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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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A Means to an End.

All costing systems are acknowledged to be a means to an end, being *per se* merely an overhead charge. That end is the rational control of an industrial concern. This control extends to the ascertainment of selling price, associated with the provision of such related figures as "unit cost price, departmental overheads, and profits." But there is a wider aspect, and one which has been given much prominence in recent years, and that is the cumulative effect of general efficient costing on an industry taken as a whole. It cannot yet be enunciated that the selling price of an article is a reasonable addition to its prime cost in any one area or country, as witness the case of the coal industry. Extraneous factors, such as foreign competition, mistakes in cost estimation, guess work, liquidations, and sometimes sharp practices may have a profound influence on a section of the market. In connection with the last factor, we have during the last few years come across a phase of "sharp practice" which requires ventilation. Foundries, especially of smaller variety, often change hands and "bad trade" is not always the excuse. It frequently happens that insufficiency of working capital is put forward as the reason for desiring to sell the business, and the seller is in a position to exhibit an order book of an extraordinarily high value for the size of the concern. The new owner generally finds to his dismay that the whole of the orders have been accepted at definitely unremunerative prices. We advise prospective purchasers of small foundry businesses to examine the order books with the greatest care, checking the prices accepted for castings with those submitted by well-established concerns. After all, the purchaser's business as a founder will be remuneratively to sell castings, and not re-sell the concern with the questionable asset of an even augmented order book, as has been done in the not too distant past.

A mistake on the low side in quoting is used by the astute buyer to induce competitors to accept lower prices than those he originally quoted, and which were presumably based on his ascertained production costs.

Guess work is definitely either the product of wide, practical experience or profound ignorance, the latter often having the same effect as an error in the buyer's favour when computing a selling price.

Foreign competition requires careful examination, as it may be competitive on account of cheaper labour, lower taxation, cheap raw materials, Government subsidy, depreciated currency, low freight charges or superior production methods. It is perhaps best always to ascribe it the last-mentioned factor, as it provides an incentive for further home effort.

Taken large and broad, all these factors require co-operative discussion by members of the industry, and their evil effect would be properly apprised if the thousands of British foundry owners would cease to worship at the altar of isolated individualism and embrace the principle of collective study for their industrial problems.

Modern Marketing.

It is pointed out from time to time that the full recovery of British trade is greatly handicapped by our inadequate appreciation in this country of up-to-date methods of marketing and selling. The latest pronouncement of this nature comes from the Advertising Convention, held not long ago in Birmingham. Great emphasis was laid upon the vital importance of advertising *as a part of marketing*. One speaker stressed the point by stating that "there are more and greater problems to be solved between the finished product and the consumer than between the raw material and the finished product."

In this connection it is worth while to remember that part played in the organisation of British industry by the accidents of history. Great Britain is the oldest industrial country, and, being the first in the field, her goods were everywhere in great demand in the early days, and required no "pushing" in the modern sense. Further, foreign travel, whether on business or on pleasure, was a risky matter and not one to be attempted by all and sundry. There grew up, as a result, numbers of general merchanting concerns whose business it was to act as intermediaries between the manufacturer and the purchaser in other parts of the world, and this merchanting system is fairly firmly rooted in British industrial organisation.

The more recently developed industrial countries, however, have had to face keen competition, coupled with infinitely simplified communications, and they have largely abandoned the general merchant for the special agent, sending their personal representatives all over the world. Moreover, those British industries which are at the present time the most favourably situated with regard to foreign trade are mainly those of newer growth whose marketing is able to compete with the marketing of other countries, notably Germany and America. The older industries still rely largely on out-dated methods, and the struggle is a bitter one for them.

It is by no means uncommon to hear that some new and rapidly developing market, such, for instance, as the Argentine, is practically untouched by British manufacturers because their marketing methods are behind those of their rivals. Some statement to this effect was to be found in almost every one of last year's trade reports. They are slow to inspect the field in person, or to send efficient proxies for the purpose; slow to send adequate representatives; slow to spend money on advertising.

The same lesson cries aloud to be learnt from the fact, commented on repeatedly in these pages as in those of any discerning journal, that the British exhibitors and the British visitors at foreign trade fairs and exhibitions are almost always in a minority. The value of these events should be sufficiently evident in view of the importance we attach to our own British Industries Fair and the amount of business we see transacted there. It appears probable that the root of the trouble lies in the traditional insularity of the English people, an insularity which is little short of ridiculous to-day, in face of the ever-growing internationalisation of life.

XUM

A Dominion Visitor Entertained.

Dinner to Welcome Mr. R. W. Williams, of Sydney, Australia.

There was a happy little gathering at the Engineers' Club, Coventry Street, London, W., on Monday, June 18, when members of the Foundry Trades' Equipment Association entertained to dinner Mr. Reginald W. Williams (of Messrs. Sidney Williams, of Sydney, Australia). This is in accordance with the practice, which has been followed for a number of years, of entertaining and welcoming visitors who are connected with the foundry industry in our overseas Dominions, to make them feel at home here and to discuss matters of mutual interest. Mr. A. S. Beech (Vice-President of the Foundry Trades' Equipment Association) travelled from Scotland in order to preside in the unavoidable absence of Mr. H. Winterton, the President.

MR. V. C. FAULKNER (Past-President of the Institute of British Foundrymen and of the Foundry Trades' Equipment Association, and Editor of THE FOUNDRY TRADE JOURNAL) proposed the health of Mr. Williams and extended to him a hearty welcome. In addition to their desire to welcome Mr. Williams to this country, he said, those present had two other reasons for asking him to that function. In the first place, as Britishers, they wanted to increase their business with Australia. In the second place they wanted him to make propaganda in Australia for the exhibition of foundry plant and products which was to be held in London in June, 1929. They felt sure Mr. Williams would be glad to accord to them the favour of telling all his friends in Australia that this interesting exhibition was to be held in conjunction with an international convention.

Reaching the Australian Founder.

What we in this country were always anxious to know from visitors such as Mr. Williams was how we were to do trade with Australia. Owing to the fact that distances in this country were not great, an organisation could have its representatives in Birmingham, Manchester, the North-East Coast, and so on, but it could not afford to maintain a representative in Australia unless it could sell a reasonable quantity of goods, because the distances between the various cities in Australia were so great that the profits would be swallowed up by travelling expenses. Certain of the members of the Foundry Trades' Equipment Association carried stocks in Australia, and they were now considering the possibilities of forming a joint stock company there, representing a number of interests in Great Britain, for the purpose of selling direct to the Australian founders. Before they could do that, however, they must have a sporting assurance that they had the right goods to sell there. He did not know of what the bulk of the machinery used in Australia consisted, but would hazard the guess that it was American. That was deplorable. He admitted that a certain number of American machines were used in this country, but believed that we were now in a position to say that we had improved upon the major portion of the machinery that was imported from America, and that we had placed improved machines upon the market. Apart from that, there were certain specialities which were definitely the creation of the foundry people of this country, and which we considered to be in advance of anything American. He could assure Mr. Williams that so far as machinery was concerned, he could buy in Great Britain anything equal, if not superior, to any other machinery to be found anywhere else in the world. Our trouble, however, was that of marketing. There was no difficulty when erudite people such as Mr. Williams took the trouble to come to Great Britain and see what we had got, but the vast majority of founders in Australia could not do that. In Australia and New Zealand there were at least 600 foundries, all users of machinery and all growing concerns. The market was one in which we were all interested, and if we could find through Mr. Williams any rational means of meeting the needs of that market we were sufficiently advanced in our ideas of business to adopt those means.

In conclusion Mr. Faulkner asked Mr. Wesley Lambert, the President-Elect of the Institute of British Foundrymen, and who was unconnected with the Foundry Trades' Equipment Association, to support the toast, and to say how pleased the foundrymen of Great Britain were to see Mr. Williams.

Helping to Pay War Debts.

MR. WESLEY LAMBERT (President-Elect, Institute of British Foundrymen), supporting the toast, said that although reference had been made to the necessity for our Dominions to purchase machinery from this country, first and foremost the object of the meeting was to welcome Mr. Williams to England. As Britishers we were all delighted when anyone from overseas, and particularly from our Dominions, visited us, and we welcomed such visitors heartily. So far as equipment was concerned, he pointed out that we in this country were under a debt of honour to bank a very great deal of our money in America, and, D.V., we should see that every halfpenny of it was paid. As a Britisher he was proud to think that we were paying our debts; we should be able to receive the American visitors whom we expected next year without the feeling that we were not keeping to our pledges. At the same time, it did behove the Dominions overseas to see that as far as possible they did their trade with this country. Mr. Williams would quite understand that. England was an industrial country and a manufacturing country, and the life of the country was wrapped up in its industry. That being so, it was essential that the Dominions overseas should support the country's trade. If that were not done we should not be in a position to pay our debt of honour to America. He was sorry to speak in such a serious manner on such an occasion, but he realised from his own knowledge of countries abroad, and especially our own countries, that there was a tendency in those countries to foster their own industries. That was all very well. Those countries had got to develop, they had wonderful natural resources, but when they came to compete in the industries which were the life and soul of this country, and which, therefore, we could not allow to go out of the country, he felt that at least, if the countries overseas were going to foster local industries, they should come to this country for their plant. It was quite possible that the Dominions might obtain more advantageous terms from America, but, even so, we needed to foster the Empire spirit. After all, the home country was the motherland, and he did not think anyone in any of our Dominions wished to see it decline. The Institute of British Foundrymen had just held a foundry congress in Leicester, Derby and Loughborough. He was sorry that Mr. Williams was not able to be present on that occasion; had he been there he would have felt that there existed amongst British foundrymen a *bon camaraderie* such as he had had no idea of, because even in his (Mr. Lambert's) forty years' experience of the foundry trade he had never seen more enthusiasm than that displayed on the occasion of this manifestation. Those attending the congress had visited a number of works, and he had paid particular attention to the foundry equipment which he recognised as having been supplied by associations and manufacturers in this country, and, having a knowledge of American practice—for he had visited quite a number of the large American foundries—he was in a position to say that the British manufacturers of foundry equipment could supply all that was required in the foundry, and that it was equally as good, if not better than, that which could be obtained from America.

He hoped that Mr. Williams, when he returned to Australia, would convey to all his colleagues in the foundry trade there the compliments and very kind regards of British foundrymen. It was unfortunate that distance precluded the possibility of larger numbers of Australian foundrymen visiting this country, especially on the occasion of the Institute's conferences. In June next year, however, there was to be an international conference in London, and when he stated that we were expecting no less than 200 or 250 visitors from America, in addition to a large number from Germany, France, Italy, Spain, Belgium and other countries, even including Czecho-Slovakia, he felt sure Mr. Williams would be willing to indulge in a little propaganda when he returned to Australia, and would try to induce some of his colleagues to visit this country on that occasion. They would not be disappointed with their reception.

Finally, in supporting the toast, he wished Mr. Williams good health, a most enjoyable time in this country, and *bon voyage* when the time came for him to return home.

The toast was received with enthusiasm.

British Goods Preferred.

MR. WILLIAMS, responding to the Toast, said that he found it difficult adequately to express his sincere appreciation of the warm reception. He was very grateful for the manner in which he had been entertained, and for the kindness which had been extended to him.

In Australia there was no Association similar to the Foundry Equipment Association, but there was a Foundry Section of the Metal Trades Employers Association, of which he was a member. Upon his return he would get in touch with his Association and explain the express suggestions put forward that night. As a few of the members of the Sydney Branch of his Association were coming to England in the near future, he hoped that the foundry firms in this country would get into touch with them also, for they were more influential than he.

In Australia, British products were very much preferred to those of any other origin, and as members no doubt knew, the British Empire spirit was undoubtedly predominant throughout the various manufacturing industries, and also, in other directions. There were not as many foreign machines as the British foundryman would imagine there were in Australia. That was to be expected when it was recognised that tariff duty on foreign machinery was much higher than it was on the machines imported from Great Britain, some of which were duty free. That showed one way in which the Government were encouraging the Australian business man to favour British firms with their business.

There were (continued the speaker) numerous small foundries in Sydney, and several fairly large ones. If Australian foundry managers were visited by a reliable foundry expert from England he was quite sure such a person would be welcome. If that expert were an undoubted authority on modern foundry methods, and was careful not to boost especially any one maker's products more than another, he felt sure that a great deal of good would result from the visit.

The representative of the British manufacturers, after staying there some time and becoming fully acquainted with the Australian foundry trade, would then be in a position to advise regarding the formation of a joint company of the English foundry equipment suppliers. When it is considered that representatives of foreign countries have been coming to Australia for many years in an endeavour to sell their special foundry machinery, it must be realised what a necessity there is for a visit of an Englishman.

Later, MR. WILLIAMS stated that the idea of the Australians sending over a foundry representative to investigate the position in England was not altogether practicable. After all, it was better that the manufacturers' representative should place their goods before the prospective customer, rather than that the customer should have to hunt for them.

MR. WILLIAMS said that he was quite aware that some of the larger British foundry equipment manufacturers already had agents or representatives in Australia, but he seldom saw any of these agents, whereas the representatives of the foreign firms were met quite frequently. Generally speaking, Australian foundrymen were not quite aware

of the progress made in British foundries and the up-to-date equipment which was obtainable in England.

A suggestion that foundrymen of Australia should visit the great Foundry Exhibition to be held in London in June next year was a good one, and in view of the number of foundrymen who have already decided to come to England, he felt sure that some would visit the Exhibition. He would have an opportunity of conveying the information regarding the Exhibition, and expressing his opinions to some of the Sydney foundrymen upon his return.

Finally, he said he would be very pleased to convey to the foundry section in Sydney the compliments of the Institute of British Foundrymen and the British Foundry Trades' Equipment Association.

MR. LAMBERT said he realised, of course, how difficult it would be for one firm of foundry equipment suppliers to get into touch with the whole of the foundries in Australia, because the country was an immense one, and the cost of sending a representative there would be very great. He suggested, however, that much good would accrue if the equipment suppliers combined together for the purpose of sending a fully qualified technical man—a real live wire—to Australia, to advise founders there with regard to their various problems, such as, for instance, the types of machines they wanted for their particular purposes, the conditioning of sand, and all the other essentials for efficient foundry practice. Such a man would represent not one firm of equipment suppliers, but the whole of the British suppliers, and he offered that suggestion because he felt confident that such a man would be well received, and it was more than probable that good business would result, for there would be a reciprocal feeling in the matter on the part of the Australian founders.

British Stocks Carried.

MR. D. H. WOOD (Constructional Engineering Company, Birmingham), prior to proposing the health of the Chairman (Mr. Beech), said that as a manufacturing member of the Foundry Trades' Equipment Association he desired, on behalf of his co-manufacturers, to extend a very sincere and hearty welcome to Mr. Williams. The manufacturers did not wish to foist their goods upon Mr. Williams and his Australian colleagues, but they would like to assure him that their services were at his disposal, and that if they could help him in any way whatever they would be pleased if he would call upon them. With regard to the exhibition to be held in June next year, he emphasised that it was to be the finest foundry exhibition ever held. Coming to the question of representation in Australia, he said that last year he had spent some time in conversation with an Englishman who had spent some thirty years in Australia representing British firms. That man had studied the literature of his (Mr. Wood's) firm, and had considered carefully their manufacturers, after which he had expressed the view that he could not do the firm justice, and was convinced that one of the principals of such a firm supplying technical manufacturers could get more business in three months than he himself could hope to get in three years. He (Mr. Wood) had replied that if the gentleman in question would go out to Australia for a couple of years or so, and hold the fort, some of the principals would try to go out to help him then. With regard to the question of stocks, Mr. Wood said he was acquainted with a firm which was in a position to deliver to any founder in Australia a complete moulding plant from stock in Melbourne.

Mr. Wood then proposed the health of Mr. Beech, the Chairman, and thanked him for having presided so ably. At the same time, he regretted the absence of Mr. H. Winterton, the President of the Foundry Trades' Equipment Association, who was unable to leave Scotland to attend the dinner.

The International Exhibition.

The CHAIRMAN, responding to the toast, pointed out, in order to avoid confusion in the mind of Mr. Williams, that the Institute of British Foundrymen and the Foundry Trades Equipment Association were two distinct bodies. The latter body was formed primarily with a view to stopping any Tom, Dick or Harry arranging exhibitions when and where they liked. These people had in the past arranged various exhibitions and told the various manufacturers that if they did not exhibit they would lose their business, and the manufacturers were being let in for these exhibitions whether they liked it or not. Consequently, they had combined together, so that, inasmuch as they were paying the piper, they should call the tune and should say when and where their exhibitions were to be held. The exhibition to be held in 1929 was undoubtedly to be *the* exhibition of its kind, and the manufacturers hoped that there would be many visitors attending from the Dominions. They knew perfectly well that there would be visitors from many foreign countries, but they would welcome more than any their brothers from the Dominions.

Receiving a Specialised Commissioner.

MR. O'KEEFE (Messrs. Adaptable Moulding Machine Company, Limited), speaking as an Australian, said that Australia always looked upon Great Britain as the mother country; the mother country had always stood by and helped the Dominions, and it was up to the Dominions to help the mother country in return. Great Britain had had "a rough passage" since the Great War, but had held up wonderfully well, and he personally believed that there were some bright stars in the firmament, and that the old country would soon be enjoying greater prosperity. He could say from personal experience that the people in the Dominions were always sympathetic, and always gave preference to anything British. The trouble with Australia was that it was so far distant that it was difficult to maintain personal contact and to give the service that was needed. Some time ago he had advanced the proposition that the equipment suppliers of this country should combine to send a representative to the Dominions to give the trade there the best possible service, irrespective of any particular company, and to place at the disposal of the trade in the Dominions the benefit of our experience. It had also occurred to him that it would be a wise move on the part of the foundrymen in the Dominions to select their best man, let him study the foundry problems in Australia and decide what was wanted, and then send him to England to see what was done here. Once those in the industry in this country were assured that their visitor was a *bona fide* representative from the Dominions, they would show him everything there was to be seen. They would exchange experiences with him, and then he could return to Australia and advise the trade there as to what would be the most suitable equipment to install. In that way many of the troubles of the industry in Australia would be solved, for the foundrymen of this country had years of experience which would benefit greatly the foundrymen of the Dominions. Those in the industry in this country would be glad to help Mr. Williams in any way they could, whether it was in connection with their own particular line of business or not. If a man had not the necessary experience of a particular problem, he would put Mr. Williams into touch with someone who had. There was a great deal more pleasure to be derived from business if a spirit of helpfulness and mutual co-operation prevailed. When he had first come to this country one felt that one wanted to avoid meeting competitors, but to-day competitors were good friends, and derived much benefit from their association. Finally, he assured Mr. Williams that if he could be of service in introducing him to those who could help to solve his problems he would be happy to render him that assistance.

Reports and Dividends.

Greenwood & Batley, Limited.—Final dividend of 2½ per cent. on the ordinary shares, making 5 per cent. for the year.

Edgar Allen & Company, Limited.—Profit, £22,366; brought in, £18,374; ordinary dividend of 6d. per share, tax free; carried forward, £15,529.

W. T. Henley's Telegraph Works Company, Limited.—Final dividend of 2s. 6d. and a bonus of 1s. per share on the ordinary shares, making 25 per cent. for the year.

Random Shots.

Le(ice)st(er) we forget, we can still hear the echoes of the roar that greeted the remark of one speaker at the Convention that "It could be taken for granted that any question asked by Mr. Shaw was one to which nobody could reply." At Leicester, too, general approval was secured by the award of the Oliver Stubbs medal to Mr. J. W. Donaldson, for it was an award thoroughly in keeping with the intentions of the donor. Mr. Stubbs' unfortunate illness naturally occasioned much concern, although it was reassuring to hear that he is now showing marked improvement.

* * *

I read the other day—I am afraid at several removes from the original source—that a course in tourist psychology has recently been inaugurated in Berlin. I feel rather like saying, "I told you so," for it is a highly opportune confirmation of my statement that when it comes to the entertaining of visitors from abroad they take themselves far more seriously on the Continent than we do in England.

* * *

At the same time I could feel for the writer whose comments on the news expressed a fear lest "le tourisme," as the French would call it, should become over-organised. Of course, I am quite prepared to admit that may be lazy, or I may be eccentric, or I may be quite devoid of conscience; that is a matter of opinion. But when I *do* get any time to spare from business, whether I am at home or abroad, I have a certain preference for amusing myself, and my idea of amusing myself abroad involves being left alone. I like to see the place I happen to be in, but in a leisurely fashion, under the guidance of a loquacious and almost certainly mendacious cab-driver; or from the "terasse" of its principal café over a glass of its characteristic drink. I never believe in allowing my serenity to be disturbed by the knowledge of so many Old Masters left unadmired, so many Gothic cathedrals ungaped at, so many battlefields untraversed. Now and then I renew acquaintance with an old friend, or seek out a new one, and become for the nonce your true highbrow, but *only* now and then. . . .

* * *

I seem to have devoted a lot of attention lately to this business of going abroad, but at least I am in good company, for the holiday season is upon us, and had it not been for the latest in Atlantic flights, mutiny at sea, and the Wimbledon championships it would have become generally topical some weeks sooner.

* * *

I had news this week of Professor T. Turner, who, as many people know, has spent the greater part of this year on a visit to Australia. He and Mrs. Turner, after leaving Adelaide, visited the eastern states of Australia, and expect to return to England about August, via Vancouver and the U.S.A. The professor commented to a newspaper reporter on the temporary depression in the Australian mineral industries, and the need for more metallurgical teaching in the universities. The end of the same interview gave evidence of the tendency to Americanisation that is now, and then to be detected in the Dominions. One is reminded forcibly of American journalistic methods by the inclusion of comments—dare one suggest prompted?—on the city of Adelaide, on its beauties, and on its women. The last-mentioned were described as "clean and wholesome," and the universally sun-tanned skins also came in for attention.

* * *

Betty was anxious to put to the test her brother's vaunted superiority of knowledge. "Name six birds," she told him.

"Sparrow," began Bobbie confidently, "thrush, eagle, flamingo . . ."

"Get on with you," gibed Betty. "I know more'n you, after all. Flamingo's not a bird, it's a horse!"

* * *

And here is another film caption to support my view that they are occasionally humorous: "If you give a woman too much rope she'll skip!"

MARKSMAN.

Steel Castings for Severe Service.*

A Summary of Recent American Practice.

By John Howe Hall.

[American Exchange Paper.]

This Paper is written not with the intention of giving data on newly-developed metals suited to endure severe service, but rather of pointing out and commenting upon certain tendencies in recent American practice, especially that of the past decade. During this period, as a result perhaps of experience gained during the war, the properties of the various carbon and alloy steel castings have been studied more carefully than ever before, both by the makers of castings and by their customers, and great progress has been made toward what might be called the rational method of selecting materials, as opposed to the haphazard methods that formerly obtained. Where in past years castings, of certain metals that had proved successful for some particular type of severe service, were tried almost at random, and frequently in defiance of all reason, for almost any sort of use that might be proposed, to-day the nature of the service is studied, the characteristics of a metal suitable for such service as far as possible determined, and the field of available metals searched for those that may reasonably be expected to withstand the conditions to be encountered. When, as is still quite often the case, no suitable material appears to be available, the search for metals possessing the requisite properties is to-day carried out in accordance with carefully-reasoned programmes, far more often than was the case twenty or even fifteen years ago. Too often, in those easy-going days, a foundryman would say—"Yes, we'll furnish our so-and-so steel for your service, and feel certain it will give you satisfactory results"; and, if, as frequently happened, the result was dismal failure, dismissed the case from his mind with the encouraging thought that there were plenty of other profitable orders to be had that did not involve much trouble in the selection of suitable steels.

Perhaps, in the last analysis, the surplus of productive capacity that was a legacy of the war, and which had forced us all to put forth our best efforts to hold our trade in the face of the keenest kind of competition, has been the greatest contributing factor in forcing foundrymen to study their product and sell it only where it may reasonably be expected to pay for itself by the service it gives. The sales, executive, and manufacturing expense of wasted effort, in marketing castings where they fail to give satisfaction, has become a luxury that no concern can longer afford.

There are a number of kinds of severe service for which several distinct types of castings are being marketed to-day. Among these are heavy wear, severe and constantly-repeated dynamic loads, heavy pressure (frequently associated with comparatively high temperature), atmospheric or chemical corrosion, and erosion due to exposure to high temperatures. Frequently, two or more of these conditions may have to be resisted simultaneously, as, for instance, wear accompanied by constantly-repeated heavy stresses, or chemical corrosion accompanied by high internal pressures. Unfortunately, too, in spite of the progress that has been made, it is still too often the case that the design and dimensions of the casting have been determined, and cannot be altered, before the characteristics of the metal that is to be used have been considered, imposing an unnecessary burden upon the engineers called in to solve the problem of furnishing a satisfactory metal for the case in hand.

The Limitations of Manganese Steel.

Fifteen or twenty years ago 12 per cent. manganese steel, the invention of Sir Robert Hadfield, F.R.S., was generally thought of as being suitable for resisting severe abrasive wear of all kinds, and generally no other metal was even considered for an application demanding resistance to wear, until manganese steel had been tried. If, on repeated trials, manganese-steel castings were found to wear out in less time than was expected, it was immediately suggested that the castings furnished were "not up to standard," and they were often carefully examined and tested to discover in what respect they differed from other manganese-steel castings. Only during the last ten years has it been generally recognised that heavy pressure or pounding must be associated with the abrasion if manganese-steel castings are to develop their full power of resisting wear. This is because manganese steel in the heat-treated condition is only moderately hard, about 190 Brinell, so that it is easily scratched by hard particles of abrasive materials; but when severely cold-worked it develops a hardness at the surface of some 550 Brinell, making the surface almost impervious to penetration by gritty materials, even if under heavy pressure. This cold-working, in a great many cases, is accomplished by the material being handled or crushed, as is the case, for instance, in a stone crusher. In applications like this, where the steel is subjected simultaneously to abrasion and severe pressure, the hardness of the successive layers of the casting, as it slowly wears away, is automatically brought to over 500 Brinell by the cold-working that results from the severe pressure, so that the very conditions that tend to wear away the metal, at the same time armour it against further wear by encasing it in a hard, wear-resisting skin; somewhat as the effect of certain diseases upon the bodies of animals is to generate in their blood an anti-toxin that renders them thereafter immune to the illness from which they have suffered.

Mr. John Howe Hall.

Mr. Hall is the author of the paper on "Steel Castings for Severe Service," which was presented on behalf of the American Foundrymen's Association. He is metallurgist to the Taylor Wharton Iron and Steel Company, High Bridge, New Jersey.

There is, therefore, a wide range of conditions where castings have to resist what might be termed pure abrasion, in which 12 per cent. manganese steel has been found quite unsatisfactory, either lasting no longer than plain carbon steels, or not outlasting them sufficiently to make up for its higher cost. Typical examples are clay-working and brick-making machinery, Chili mills and similar machines grinding sand or ores, especially wet ores, excavating machinery handling clays or loams containing many fine particles of quartz or other hard minerals, etc. That the failure of manganese steel to resist successfully wear of this type is characteristic of the steel, is demonstrated beyond dispute by the fact that, when tested in wear-testing machines, where pure abrasion is the dominating condition, manganese steel fails to outwear carbon steels of equivalent original hardness, or outwears them but little; while in wearing tests on a laboratory scale, in which the wear is accompanied by heavy pressure, manganese steel outwears carbon steels eight or ten to one.

So far as the author is aware, no steel or iron has yet been found that will resist pure abrasive wear of this type, as satisfactorily as manganese steel resists wear associated with heavy pressure or blows. This is simply another way of saying that, as the severity of the actual wear increases, the ability of all metals to resist that wear rapidly decreases; the limiting conditions are those of the sand blast or the abrasive wheel, which wear away one metal almost as fast as another. The best solution of the difficulty so far found appears to be to use chilled-iron castings when the conditions are such that the strength of the part per unit of cross-section need not be high, and to employ high-carbon steels hardened at the points where the wear is concentrated, in cases where strength is absolutely essential to resist breakage. Steels containing from 0.5 to 2.0 per cent. of chromium and carbon from 0.50 to 1.00 per cent. find many applications in service of this type, the function of the chromium being to intensify the hardness obtained by heat-treatment. Many parts, such as the teeth of excavating machines of various types, are so designed that they can readily be removed for periodical dressing and re-hardening in the smith shop, this practice being practically universal in cases where it is essential that the cutting edge of the teeth be kept sharp.

Because the elastic limit of manganese steel in both tension and compression is comparatively low, some 17.8 to 20.0 tons per sq. in., stresses in heavy service may exceed the elastic limit of manganese-steel castings, unless they are made so bulky as to be unusable. Stresses beyond the elastic limit, constantly repeated, harden the steel just as any other cold work does, and as it hardens it loses its toughness, so that it soon cracks; the crack once started spreads rapidly, and the piece breaks. In other words, manganese steel is not well suited to resist fatigue. In some cases this can be taken care of by increasing the sections of the part so as to bring the unit stresses below the fatigue limit, but often the exigencies of the design do not permit of this, and the casting has to be made of a metal that resists wear perhaps only one-fifth as well as manganese steel, but has greater power of enduring the service stresses. It will take longer to wear out this casting than it would to break the manganese-steel piece, though the latter might last five times as long as the former, if only it could be made heavy enough to stand the severe stresses, so that it would not break, but wear out.

Composite Steels.

One of the most conspicuous examples of the impossibility of applying manganese steel to certain castings subjected to heavy wear, is the large driving pinions with cast teeth often used in rolling mills. Manganese steel castings have proved successful for the pinions of small mills, but, in the large sizes, they have invariably failed by breakage before their teeth were much more than rubbed smooth. The rather obvious solution of making the shaft of a heat-treated steel capable of resisting the stresses, with a manganese steel pinion mounted upon it, has so far not been undertaken, on account of the cost involved. Nickel or nickel-chrome steels, with the carbon as high as prudence will permit, have been used for these castings to some extent, and a number of pinions have been made of ordinary cast steel poured into a mould coated with a paste of fine ferro-manganese, or metallic manganese, and oil. The result is a casting of normal cast steel, with a

* A Paper presented to the Leicester Convention of the Institute of British Foundrymen.

hard skin perhaps $\frac{3}{4}$ in. or $\frac{1}{4}$ in. thick containing a variable, but high, percentage of manganese and carbon. The extra wear obtained from this hard skin is usually sufficient to pay for the cost of the process.

Autogenous Welds.

In recent years attention has been called to the fact that autogenous welds in manganese steel castings are in the majority of cases unsatisfactory, so that attempts to prolong the life of cracked or worn manganese steel castings used in steam or electric railway track are frequently unsuccessful. In the effort to secure a metal that might be satisfactorily welded, so that worn parts could be renewed and a greater life per pound of investment received than is possible with manganese steel pieces, medium carbon nickel-chrome steel castings have been tried out on an extensive scale in several American cities. The composition of the steel used is C., 0.45 to 0.55; Si, 0.25 to 0.50; Mn, 0.60 to 0.80; Ni, 2.50 to 3.00; and Cr, 0.75 to 1.00 per cent., whilst the physical properties secured from cast coupons treated with the castings, are approximately Tensile Strength, 42 to 53 tons per sq. in.; Elastic Limit, 24 to 35 tons per sq. in.; Extension in 2 in., 12 to 22 per cent.; Reduction of Area, 15 to 40 per cent.; and Brinell Hardness No. 210 to 240.

Engineers are not yet in agreement as to the possibility of securing truly satisfactory welds in worn or cracked nickel-chrome castings of this analysis, and a special committee is at present investigating the subject. It is an undeniable fact that the heat of autogenous welding, and especially of thermit welding, renders the chrome-nickel steel close to the weld exceedingly hard and brittle. Unless the casting is rigidly supported, therefore, an extensive weld such as one joining a casting to a rail, or a repair of a serious crack in the base, is apt to give way in a comparatively short time.

The data so far available as to the rate of wear of these chrome-nickel track casting is confined to cases in which the car wheel rides on its flange in the bottom of the groove at the point where the two rails cross—the so-called "flange-bearing crossings" used in electric railway service. In castings of this type the groove has to be repaired by welding as soon as enough wear—from $\frac{1}{16}$ in. to $\frac{3}{4}$ in.—has occurred to allow the treads of the wheels to ride on the casting. Owing to the low elastic limit of manganese steel, quite a part of this wear in the case of manganese steel castings is actually the flow that occurs while the metal is being work-hardened, and this flow takes place at first quite rapidly. The published figures for the comparative rate of wear of manganese steel and of nickel-chrome steel castings of this type, therefore, are somewhat misleading, and are not representative of the relative lengths of service that would be obtained on tread-bearing type crossings and switches such as are used in steam railway service. No attempt has been made to use chrome-nickel track castings on the steam roads, but a considerable tonnage of electric railway castings has been produced in the past five of six years, and in several of the large American cities they are still being installed on an extensive scale.

High Resistance Heat-Treated Castings.

Probably the greatest advance in steel-casting manufacture during the past decade has been made in the field of heat-treated castings of high strength and toughness for resisting heavy stresses. War time experience familiarised both foundrymen and their customers with the possibilities of improvement in the "common or garden" variety of steel castings so generally made fifteen years ago, and thus paved the way for this development, and the steady increase of power and capacity per unit of weight in machines of all types created an urgent demand for high-grade castings. The change in the situation since 1909, when the author's company put on the market the first heat-treated steel castings (aside from manganese steel) manufactured in America, has been most striking. The late Dr. Henry M. Howe, our Vice-President and Consulting Engineer at that time, assured us then that the properties of those castings had never been equalled or even approached by those of any other cast steel of which he had heard; yet aside from the application for which it was developed, the buckets of ladder-type gold-dredges, no market could be found for castings made of this material. The demand for a steel casting with unusually high strength and toughness simply did not then exist. To-day heat-treated steel castings of the same composition as that of the steel we have made since 1909, are being produced by at least a dozen foundries, and the number of successful applications to which they are being applied is mounting into the scores, if not the hundreds. In some cases the castings are heat-treated by quenching in water or oil and tempering, in others they are normalised and tempered. The range of analysis of steel of this type is about as follows:—C., 0.20 to 0.40; Si, 0.20 to 0.50; and Mn, 1.10 to 2.00 per cent.

In addition to the manganese, some makers use vanadium in amounts up to 0.30 per cent. or molybdenum up to 0.50 per cent. Occasionally nickel in amounts up to 1.50 per cent. is used with the manganese. The range of properties obtained from cast-on test pieces of this steel, treated with the castings by quenching and tempering, is as follows:

Maker.	M.S. tons per sq. in.	Y.P. tons per sq. in.	E. per cent. in 2 ins.	R.A. per cent.	Brinell.	Bend $\frac{1}{2}$-in. to 1 in.
A.	35.7 to 44.6	22.3 to 33.4	20 to 27	38 to 62	170 to 190	180
B.	51.3 to 55.8	33.4 to 40.0	13 to 20	25 to 35	250	—

Maker B uses a considerably higher carbon content than maker A, and heat-treats for high strength with moderate toughness. Maker A heat-treats for the maximum obtainable toughness, with moderately high-strength.

The properties obtained by various makers of steels of this analysis, heat treated by nomalising and tempering, are as follows:

M.S. tons per sq. in.	Y.P. tons per sq. in.	E. per cent. in 2 ins.	R.A. per cent.	Brinell.	Bend $\frac{1}{2}$ in. to 1 in.
33.4 to 44.6	17.8 to 29.0	20 to 35	35 to 55	170 to 200	140 to 180

In addition to excellent static tests, cast steels of this analysis have unusually high shock-toughness, published figures for Charpy tests ranging from 13 to 32 ft. lbs., as compared to 6 to 10 ft. lbs. for ordinary cast steels of 0.25 to 0.35 per cent. carbon. The endurance limit also is high, varying from 42,000 to 47,000 lbs. per sq. in., as compared to 33,000 to 37,000 lbs. for ordinary cast steels of 0.25 to 0.35 per cent. carbon.

By the addition of about 0.20 per cent. vanadium the tensile strength and elastic limit of these steels can be increased about 4.4 tons per sq. in. without marked decrease in extension or reduction of area. After normalising and tempering the properties of steels containing about 0.35 per cent. carbon, 1.25 to 1.50 per cent. manganese, and 0.18 to 0.22 per cent. vanadium, are as follows:—

M.S. tons per sq. in.	Y.P. tons per sq. in.	E. per cent. in 2 in.	R.A. per cent.	Brinell.
42.8 to 53.5	26.3 to 37.0	17 to 25	26 to 45	187 to 240

Similar results are being secured by additions of from 0.20 to 0.50 per cent. molybdenum, and steel with equally good properties is being produced in which the manganese averages about 1 per cent. and the nickel about 1.25 to 1.50 per cent.

Nickel-chrome steels of from 0.25 to 0.40 per cent. carbon, with nickel from 1.50 to 2.50 per cent. and chromium from 0.60 to 1.00 per cent., are also being produced, with properties approximately as follows:

M.S. tons per sq. in.	Y.P. tons per sq. in.	E. per cent. in 2 in.	R.A. per cent.
40.0 to 53.5	24.5 to 33.4	15 to 25	25 to 40

Industrial Applications.

As a rule the chrome-nickel steels are being used in applications where the castings must have not only great strength and toughness, but the ability to resist wear as well, as for instance, in the treads or shoes of tractors, tanks, and "crawler type" steam shovels. Certain of the tractor manufacturers are using 12 per cent. manganese steel for these castings, while others demand nickel-chrome or some other machineable type of heat-treated cast steel. The advocates of the machineable steel point to the fact that the fits between the pins and their holes are not as good in manganese steel as in the nickel-chrome steel, and claim also that the manganese castings, on account of their low elastic limit, stretch in the pin holes and so get "out of pitch" with their sprockets. This latter claim is vigorously denied by the advocates of 12 per cent. manganese steel, who point further to the fact that the castings of the latter steel are received from the foundry ready to install on the machine, without expense to the tractor maker for heat treatment, machining, and loss of defective castings.

The ability of manganese steel to resist the wear to which tractor shoes are subjected is a further argument in its favour. As so often happens in similar cases, very few comparative tests of the two metals under parallel conditions have yet been made, so that it will probably be some time before the question of which type of steel is the better for this service is satisfactorily settled.

Successful applications of the high-strength cast-steels include motor truck wheels, various heavily stressed parts of motor trucks and machinery, anchor chain, coupler knuckles for railway cars, locomotive drive wheel-centres and other locomotive castings, and even large-sized locomotive frames, which are now being produced in quantity of several different types of alloy steel, usually normalised and tempered. The progress that has been made of late years by foundries producing locomotive frames is evidenced by the fact that they are now ready to accept a specification which will apply to frames, as well as to other heavy castings, calling for minimum physical properties (as shown by integrally cast test pieces) as follows: Maximum stress, 37.5 tons per sq. in.; yield point, 22.6 tons per sq. in.; elongation on 2 in., 22 per cent., and reduction of area, 40 per cent.

This is a marked contrast to the American Society for Testing Materials 1918 Specification, "A 27—16," applying to steel castings for railway rolling stock, which called for the following properties:

Grade.	M.S. tons per sq. in.	Y.P. tons per sq. in.	E. per cent. in 2 ins.	R.A. per cent.
Hard ..	35.7	0.45 × M.S.	15	20
Medium..	31.2	,,	18	25
Soft ..	26.7	,,	22	30

It will be seen that even on the coupons from so large a casting as a locomotive frame, the foundries are now willing to guarantee minimum values for extension equal to, and for reduction of area considerably better than, those of the 1918 specification for "soft" steel, and at the same time a tensile strength equal to that of the 1918 "hard" grade, and a yield point considerably higher than that of the 1918 "hard" grade.

A large amount of work is being done to determine the relation between the properties of the steel in various parts of heavy castings, as shown by tests trepanned out with a core drill, and those of tests cut from cast-on test pieces. In several quarters the impression prevails, based upon scanty and insufficient evidence, that if only the proper procedure be employed in the heat-treatment, core drill-tests from heavy castings can be made to give properties as good as those of the coupons. Several of the more progressive foundries are in possession of sufficient data to show that this is not true, and that the properties of the core drill-tests vary greatly, depending upon the part of the casting from which they are taken, and other factors as yet undetermined. Within the next few years sufficient data will be collected to enable an intelligent specification to be drawn for the properties of tests trepanned from castings. At present such data are largely lacking.

Heat Treated Castings.

A curious perversion, as it were, of the present efforts to substitute heat-treated cast steels for the plain steel castings formerly furnished, wherever the increasing severity of the service stresses demands it, is the specifying by several railways of 12 per cent. manganese steel for a number of comparatively small truck castings, in which wear is not involved. Breakage of regular

grades of steel castings in this service has been frequent, and better castings were sought by those in authority. Learning of the good results received from 12 per cent. manganese steel castings in many classes of service involving wear, and finding them to be tough and strong, the shop foremen have specified them for repair work, regardless of their greater cost, their total lack of machineability, and the fact that the service does not involve wear, the one condition that justifies the purchase of 12 per cent. manganese steel. Several grades of heat-treated machineable castings could be purchased from any one of a number of foundries that would be more satisfactory than manganese steel; but the latter has been tried and found equal to the stresses imposed upon it, and for the present that is enough for those who are doing the specifying and the buying.

Those who, like the author, have been advocating for years the use of mild cast steels with manganese from 1 to 2 per cent., and who have steadily pointed out the falsity of the widely held opinion (first shown to be false by Guillet) that manganese in these proportions makes steel brittle, have been disturbed of late by the tendency of some of the shops now developing these steels to go too far in raising the strength and elastic limit of their castings at the expense of the toughness. Several concerns which have only comparatively recently undertaken the manufacture of these steels, have become so enthusiastic over the possibilities of securing high elastic limit in their castings that they have gone to extremes in this direction, and are, in the author's opinion, producing castings with far too little ductility, especially ductility under shock. By using a relatively high-carbon-content, a high content of manganese, and a low temperature for the tempering that follows normalising, the tensile strength and the yield point are in some cases being raised to figures almost undreamed of a decade ago, but in the rage for high elastic limit, the vital necessity of toughness and ductility is being forgotten.

After all the efforts that have been made to convince engineers that steels containing 1 to 2 per cent. manganese, when properly made, are not brittle, it is a pity that castings should be turned out by reliable firms that are so strong and relatively brittle as to be liable to fail suddenly and unexpectedly in service, and thereby to spread again the false impression that manganese in these quantities makes steel treacherous and brittle. Unfortunately, too, a great many of these over-strong castings have gone into locomotive service, exactly the place where the failure of a casting will be the most disastrous, and where such a failure will be brought to the attention of the greatest number of people.

Heat Resisting Steel Castings.

"Valves, flanges, and fittings for high-temperature service" has of late become a familiar phrase to engineers, because of the discussions before a number of technical societies over the question of specifications for these important parts. The great increase in the temperature and pressure of superheated steam generated in modern power houses, and the equally high temperatures and pressures used in the oil refineries and cracking plants, have made the manufacture of valves and fittings for this severe service a difficult task. Specifications are now in existence for castings to be used at temperatures up to 400 deg. C., and certain engineers are demanding that specifications be drawn for castings capable of withstanding even higher temperatures. Mention is freely made of steam being generated at 1,400 lbs. pressure and even higher, and in the oil refineries temperatures as high as 535 deg. C. and pressures up to 900 lbs. are sometimes encountered. Tensile and other tests at these elevated temperatures are being made on the metals used in valves and fittings in the effort to find those that retain the maximum possible proportion of their "cold" strength at higher temperatures.

It has not taken long for testing engineers to discover that at these high temperatures the ordinary "short-times tests" are of relatively little value as a check on the behaviour to be expected of the metals in service, as "creep" or slow stretch has been found to be the determining factor in the life of the fittings. Stretch at a rate so slow that only after days or weeks does it become measurable with delicate apparatus has been found eventually to cause failure of valves and fittings, so that to-day the leading makers of these parts are carrying on extensive investigations of the amounts of this slow stretch or creep at elevated temperatures. A new property, the "creep point," has been added to the familiar quartette—tensile strength, elongation, extension, and contraction, and to obtain a metal with the highest possible creep point at working temperatures is the constant aim of the manufacturers.

Sound Castings an Essential.

Some of the makers of these parts use plain carbon steel, some use a steel with manganese from 1 to 2 per cent., and some employ nickel, nickel-chrome, or other alloy steels. Whatever be the composition selected, the soundness of the castings is the most important factor in the production of satisfactory parts, for a casting of low tensile-strength steel that is entirely free from piping, shrinkage cavities, sand inclusions, or blow holes, will as a rule endure longer under severe service conditions than an unsound casting of much stronger steel. In the effort to ensure the production of satisfactory castings, designs are being carefully revised by the foundryman and the designer, in order to eliminate all features that make it difficult to secure sound castings, and methods of production in the foundry are being intensively studied. The best size and shape of gates, sink heads, etc., for each pattern is carefully determined by the examination of check castings, and once the best methods have been determined, the utmost pains are taken to standardise patterns and equipment so that none but the desired procedure can be followed. By hydraulic tests, by cutting up castings, and in the case at least of some concerns with an appreciation of the advertising value of "something new," by X-ray examination, the soundness of the castings is subjected to the severest scrutiny, in an effort to eliminate the occasional defective ones. In the case of at least one power-house recently erected, the specifications called for the X-ray examination of every cast steel valve and fitting furnished, and the rejection of any casting found to contain cavities or sand inclusions of sufficient size to be considered harmful to its strength.

The nickel-chrome alloys containing very high proportions of nickel and chrome, so extensively produced to-day for castings subjected to temperatures above a red-heat and to chemical corrosion, do not come within the scope of this Paper because they are not steel. They are made in a great variety of shapes for tempering, case-hardening and cyaniding pots, resistance grids for industrial heating, parts for furnaces used for heat-treating, enamelling, glass-making, etc., and countless similar applications.

Stainless Steels and Irons.

The stainless steels and irons containing from 12 to 18 per cent. chromium and carbon not over 0.50 per cent. and their various modifications, which have been produced in large tonnages in the form of forgings and rolled bars, have not yet been extensively used for the manufacture of castings. The concerns that have been pushing these metals in rolled and forged parts naturally have not wished to engage in the manufacture of castings, because they lack both the equipment and the experience to do so with success. On the other hand, the steel foundries have been reluctant to undertake the work, on account of their inexperience in handling special steels that have to be given careful attention at almost every stage of their manufacture. As a result, only the concerns already engaged in the manufacture of the high nickel-chrome alloys have been in a position to undertake the manufacture of stainless steel castings with any chance of immediate success, and they naturally have not wished to multiply too much the number of different metals they make.

During the next few years the manufacture of castings of stainless steels and irons and similar metals will undoubtedly be developed on a large scale, since the opportunities for applying these metals in shapes that cannot be made of rolled or forged material are numerous, and are already being called to the attention of foundry executives.

Co-operation of Acetylene and Welding Interests.

A matter of considerable interest which arose at the annual general meeting of the British Acetylene and Welding Association, held at the Association's offices in London last week, was a proposal, and now almost an accomplished fact, for the closer co-operation of this Association with the Institution of Welding Engineers. This is a matter which has been exercising the minds of those concerned with acetylene and welding for a long time.

The British Acetylene and Welding Association was formed some years ago, but it was felt that, although it was doing excellent work, its field of operation was rather narrow, and that there was a need for an association to deal with electrical and other types of welding. As a result, the Institution of Welding Engineers was formed. It was soon realised, however, that the existence of two organisations with somewhat similar objects was not conducive to the general advancement of the interests of the welding industry, and efforts have been made from time to time to amalgamate in some form. Hitherto these efforts have been unavailing, but now the basis of agreement has been arrived at. A joint committee of representatives of the two bodies has been at work and has produced recommendations for co-operation.

The committee agreed that there could be no question of amalgamating the two bodies into one, as it was stated by the representatives of the Association that it was essential that, apart from the question of welding, the existence of an Association devoted expressly to the interests of the acetylene industry must be maintained. It was agreed also that the finances of the two bodies must remain entirely apart, and the prevailing idea was that, broadly speaking, the Association should represent manufacturers and the Institution should fulfil the functions of a technical society dealing with welding in all its branches.

It is proposed that the name of the Association be altered to "The British Acetylene Association" and that its membership be restricted to firms manufacturing and/or selling acetylene, acetylene apparatus, carbide of calcium and oxygen, and their employees nominated by such firms. The activities of the Association to be confined to matters relating to acetylene, acetylene apparatus, carbide of calcium and kindred subjects other than those falling within the province of the Institution, and to the making of regulations concerning them.

The proposals in regard to the Institution are that it is to confine its activities to promoting the extension of the use of welding in all its branches and to the advancement of the science of welding in all its forms, its membership to be confined to individuals, the Institution to agree that any further regulations relating to carbide of calcium shall be dealt with exclusively by the Association. It will also do its utmost to establish a standard for welding operations and for the operatives engaged in the industry.

The operation of a scheme on these lines will mean that many individuals at present members of the Association will be ineligible, but it is hoped that they will all become members of the Institution. It is also hoped that the practical welder will be attracted to the membership of the Institution in greater numbers.

The President of the British Acetylene and Welding Association for 1928-29 is Mr. P. B. Liversidge (of Messrs. Allen Liversidge, Ltd.), who served as President on a previous occasion about five years ago. He has succeeded Mr. Alexander Jackson (of Messrs. Carbic, Ltd.), who has now completed three periods of office as President. The Vice-President is Mr. Albert Hoddle (Messrs. Thorn & Hoddle, Ltd.).

THE American Ceramic Association was entertained last Friday evening at a banquet at the Hotel Cecil by their British colleagues. The visitors are touring Great Britain prior to a trip round the Continent.

British Facilities for Foundry Training.

No. II.—THE METALLURGICAL DEPARTMENT OF THE UNIVERSITY COLLEGE OF SWANSEA, SOUTH WALES.

By Percy Fox-Allin, Associate Editor of the "Foundry Trade Journal."

The Metallurgical Department of the University College of Swansea had its inception so recently as 8 years ago, being transferred to its present position in Singleton Park, one of the many beauty spots on the outskirts of Swansea, a year later. The Department has thus the advantage of entirely new laboratories, which have been specially designed for their purpose, whilst the site is adjacent to the main College buildings.

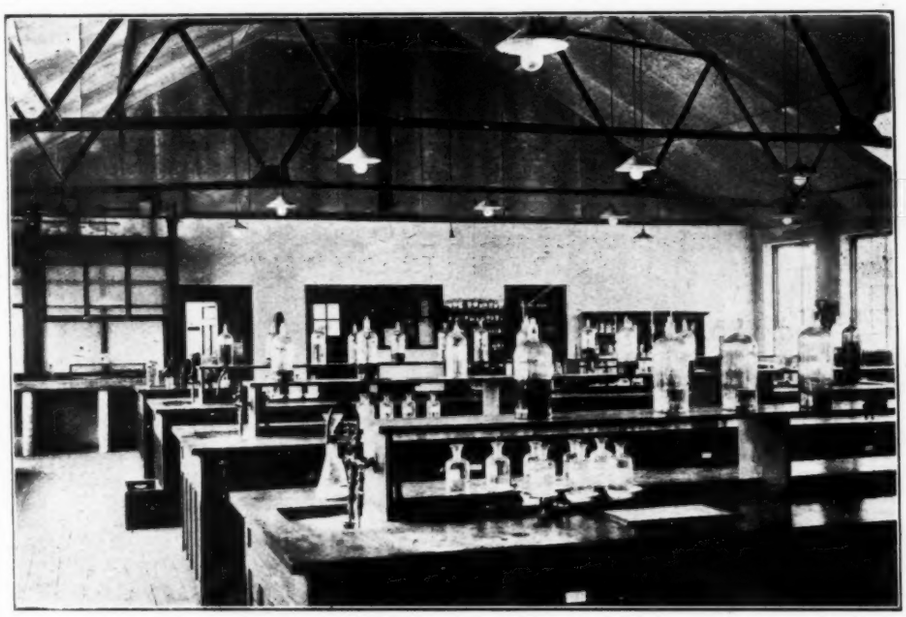

FIG. 1.—WET ASSAY LABORATORY. METALLURGICAL DEPARTMENT OF THE UNIVERSITY COLLEGE OF SWANSEA.

The accommodation includes large main laboratories, which are severally laid off for dry assaying and general furnace work; wet assaying, qualitative and quantitative and physical testing; whilst smaller laboratories are available for pyrometry, metallography, magnetic and electrical measurements, fuel and refractory materials, and electrolytic processes of refining.

The governing metallurgical industries of the surrounding districts are, of course, those of steel and tin plates, closely followed by the copper, nickel and spelter industries.

The manufacturers of the district contribute liberally to the support of the college, and at the same time afford the staff and students every opportunity of keeping in close practical touch with the manufacturing processes in the works. Local manufacturers have also taken a very appreciative interest in the research work of the Department and have made substantial grants to encourage and extend this work.

In view of the foregoing it is, one might say, a natural obligation for the Department of Metallurgy to specialise on the work of the district. The scope of the Metallurgical Department will no doubt be extended as time and circumstances permit; in the meantime, however, the Department is largely occupied in assisting local industries and the training of students on lines best calculated to enable them to control those industries in the future.

The most, one might say, the all-important feature, of the training is that the students are able to gain a considerable amount of practical knowledge during the period of their academic studies.

Industrial Co-operation.

With a view to secure the closest possible co-operation between the College and the local industries, advisory committees have been set up by the College for the ferrous and non-ferrous metallurgical sections. The committee on ferrous metallurgy includes representatives of the South Wales Siemens Steel Association, the Welsh Plate and Sheet Manufacturers' Association, and the British Mannesmann Tube Company, Limited. The Committee on Non-Ferrous Metallurgy includes representatives of the South Wales Copper Trade Employers' Association, the Spelter Manufacturers' Association, and the Mond Nickel Company, Limited, whilst on each Committee are representatives of the Council and the teaching staff of the College.

The objects of these Committees are (1) fostering the interest of the industries in the work of the college; (2) promoting the acquaintance of the staff and the students with the human and technical problems of industry; (3) setting up machinery which will facilitate (*a*) the passage of selected youths from industrial apprenticeship into courses of college study and (*b*) the placing of college students and graduates in positions which offer suitable scope for the application and development of their technical knowledge; and (4) encouraging researches directed to the improvement of industrial processes.

From the foregoing it will be evident that the Council of the University College of Swansea are doing all that is humanely possible at a university to combine with the scientific training of the student a practical knowledge of the industry and the problems with which he will have to cope in commercial life. The co-operation of manufacturers in assisting to launch students on a commercial career cannot be too strongly commended, for, unfortunately, that is one of the weakest points at most of our universities, not the fault of the university, but the lack of co-ordinated support on the part of manufacturers.

Suited to Foundry Requirements.

The Swansea University system of technical training would seem to be exactly what is required for the student taking up foundry work. With opportunities afforded him for visiting various foundries whilst still at the University he might acquire a valuable amount of practical knowledge. He would at least learn, and that is often a failing with the purely theoretically trained man, that in every craft there are problems which may be opposed to theory, but which work out all right in practice—the motor-cycle and sidecar, for example.

As already stated there are two general laboratories which are laid off for wet and dry assay respectively. Both are equipped on the most modern lines. In the dry laboratory there are five muffle furnaces and ten Morgan crucible furnaces.

In the metallographic laboratory, there is one of the newest type Reichert photomicrographic apparatus, and also the new photomicrographic apparatus by Beck, together with a number of hand-microscopes for the use of students.

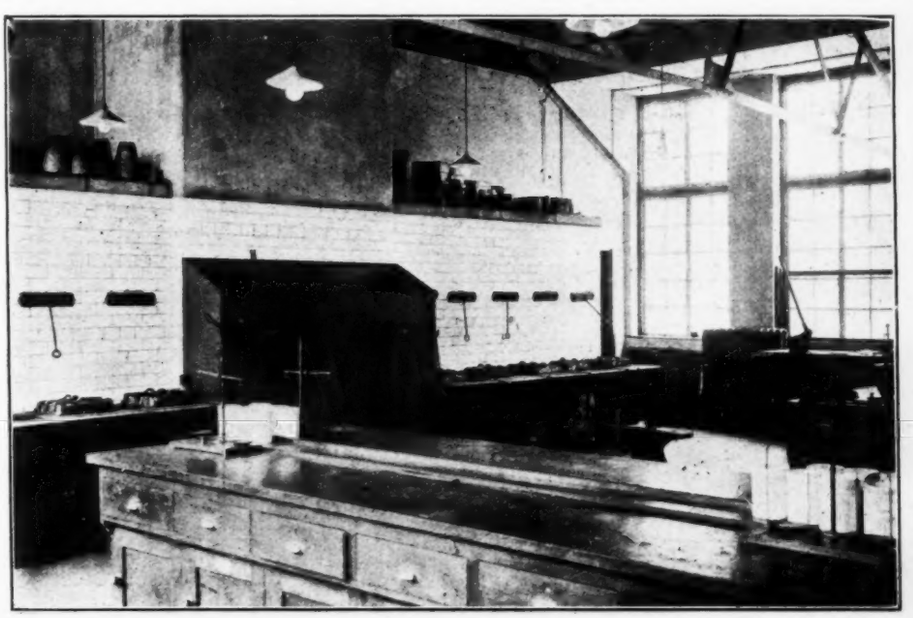

FIG. 2.—DRY ASSAY LABORATORY AND MELTING FURNACES. METALLURGICAL DEPARTMENT OF THE UNIVERSITY COLLEGE OF SWANSEA.

E

The pyrometrical laboratory contains two Carpenter-Stansfield deflection potentiometers for thermal analysis, and a Tinsley-Vernier potentiometer for accurate resistance measurement. In addition, there are several thread recorders, including a four-thread and a six-thread recorder, which are used when taking continuous temperature records in both the experimental and works scale furnaces.

Testing Equipment.

In the physical testing laboratory the apparatus installed includes an Amsler-Brinell machine, and Shore scleroscope for hardness measurement, a variety of apparatus for bend tests, which have a particular application to the tinplate industry, and an Erichsen machine for testing the ductility of tinplates and other sheet metal. A 10-ton Buckton machine is available for tensile, bending, compression and shearing tests, a Cambridge extentiometer being used on this machine. A small 1,000-lb. Avery tensile machine is especially adapted for testing thin sheet metal and wire. Tensile tests are made upon 10-ton Buckton and small Avery machines, both machines being equipped for all the usual tests, whilst a Cambridge extentiometer is also in service.

The heat-treatment department is equipped with a Batch furnace of the Incandescent Heat Company's manufacture. This furnace is for treating tin plate packs and is equipped with the usual carriage travelling on balls in V grooves. There is also a forced-draft muffle furnace, by Wright, for the treatment of tool steel.

The melting shop equipment comprises a Morgan crucible furnace which will take 100 lbs. pot and is coke fired, and two gas-fired crucible furnaces for melting non-ferrous metals. In addition there are some 20 electric tube furnaces, which are built up as required by the students. Other apparatus consists of a 4-cell electrolytic hydrogen unit, which is complete with gas holder.

There is a small transformer in the basement which steps down the current required for the electric furnaces and a rotary converter by the Crypto Electrical Company, which transforms from A.C. to D.C. 10 volts 100 amps. for plating work.

An excellent lecture theatre is also equipped for cinematograph exhibitions of manufacturing processes and works operations, the films being supplied by the manufacturers concerned. Such films are of a highly-educative character, but they are also very costly and comparatively little has hitherto been done in this direction.

The control of the Metallurgical Department is under the direction of Principal C. A. Edwards, D.Sc. (Manchester), assisted by Professor L. Taverner, A.R.S.M.

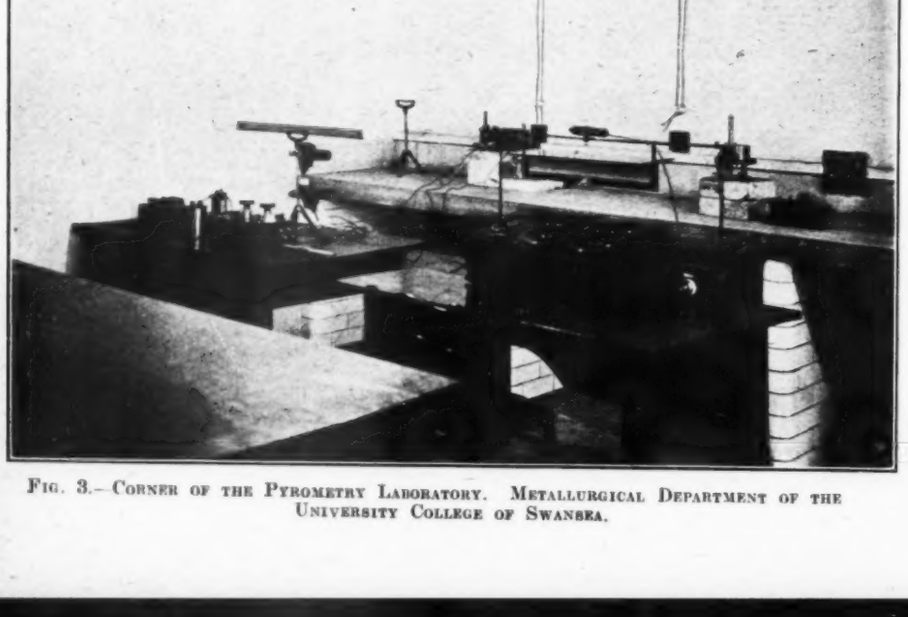

Fig. 3.—Corner of the Pyrometry Laboratory. Metallurgical Department of the University College of Swansea.

Light Coloured First-Coat Enamels for Sheet Iron.

In an item on this subject, which appeared in "Technical News Bulletin" No. 127, there were given some results of preliminary adhesiveness tests, showing the effects of treating the metal in various ways before applying the enamel. Since that time effort has been continued to improve the strength of the enamel-metal bond by treating the metal, and some treatments have been developed which, to cause failure, require loads more than 50 per cent. greater than any reported in the previous item.

Previously reported results showed that adherence was improved by allowing a thin coating of oxide to form over the iron in a furnace before applying the enamel. The application of different cobalt compounds directly to the metal also proved beneficial in varying degrees. Accordingly the combination of both treatments was tried and with better results than were obtained by either treatment alone. Best results were obtained in the application of the cobalt salts when the metal was dipped in a hot solution and allowed to remain there until it reached approximately the temperature of the bath. Cobalt nitrate appeared to be about the most desirable of the cobalt salts to apply to the iron because it decomposed on the iron with a comparatively gentle heat treatment, and the decomposition product (presumably essentially cobalt oxide) had but little tendency to float in the applied slip and stain the enamel.

The treatment of the metal selected as a standard for a series of tests which will involve a variety of enamel compositions, is as follows: the cleaned metal is dipped in a 5 per cent. solution of cobalt nitrate at about 90 deg. C. and allowed to remain until the metal is hot. On removal from the solution the piece is whirled and touched on a flat cloth to remove any excess solution from the edges. It quickly dries and is heated in a furnace at 300 deg. C. for five minutes. The cobalt nitrate appears to decompose at this temperature when in contact with the iron, and the iron simultaneously acquires a light coating of the oxide. The light-coloured enamel is then applied to the treated metal.

Adhesiveness test values have been obtained, with the above and other treatments, which appear quite promising when compared to those obtained with standard cobalt ground coats.

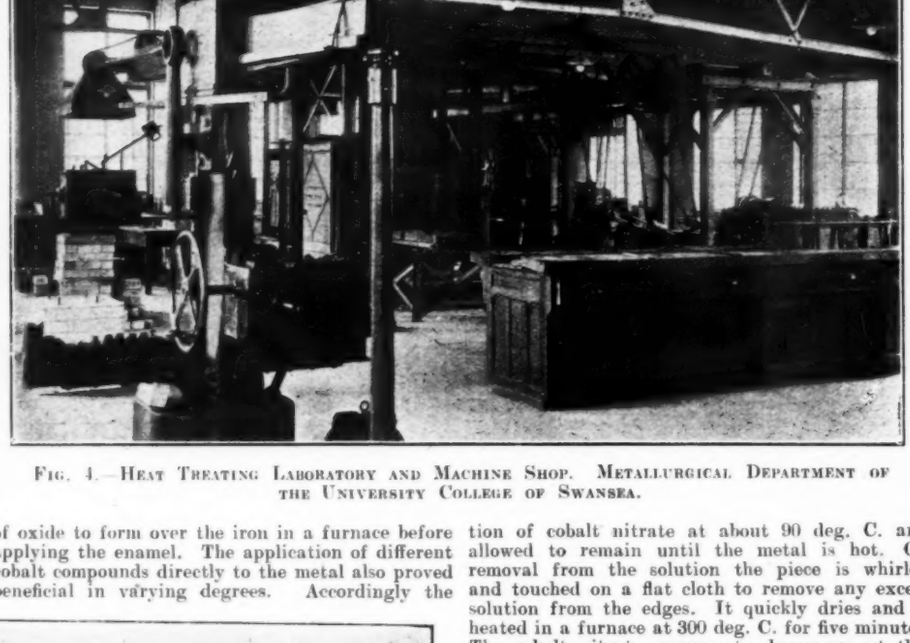

Fig. 4.—Heat Treating Laboratory and Machine Shop. Metallurgical Department of the University College of Swansea.

New Companies.

Garnett Basic Refractories, Limited.—Capital £3,000. Secretary: J. Parker, 23, King Street, London, E.C.2.

Aluminium Refinery (Coventry), Limited.—Capital £100. Solicitors: George H. Olley & Company, 161A, Strand, London, W.C.

Globe Foundry (Stratford), Limited, 43, Chatsworth Road, Stratford.—Capital £2,000. Directors: J. Yallop and W. D. Noble.

British Engineering and Metals, Limited, 69, Lincoln's Inn Fields, London, W.C.—Capital £100 in 1s. shares. Directors: R. A. Castigleone and P. J. Boaz.

Titanuite, Limited, Aldwych House, Aldwych, London, W.C.2.—Capital £100. Manufacturers of and dealers in titanium, thorium, zirconium and kindred metals, copper, zinc, etc.

Magnesite Products, Limited.—Capital £3,000 in 2,900 ordinary shares of £1 and 2,000 deferred of 1s. Makers and dealers in calcined magnesite, etc. Secretary: J. Parker, 23, King Street, London, E.C.2.

Study of Shrinkage in an Iron Casting.*

By Maurice Servais, Graduate of Ecole Nationale des Arts et Metiers (Lille) and the Ecole Supérieure de Fonderie (Paris).

[FRENCH EXCHANGE PAPER.]

The purpose of this Paper is to endeavour to examine the process of shrinkage in a grey iron casting. The study originated from a difference of opinion between M. Goujon, the French metallurgist, and M. Ronceray. M. Goujon has written a book in which he gives an account of experiments made by him on the subject of shrinkage. He constructed a frame as shown in (1) of Fig. 5, in which the thin parts A varied in thickness from 5 to 30 mm., and the thick parts B measured 40 mm. On this point he wrote as follows:—

"In these castings certain very curious anomalies occur which would tend to show that it is the thin parts that have the least shrinkage." He adds: "If the shrinkage had taken place normally the parts A ought to have diminished in length much worse than the parts B, and consequently would have caused the end-pieces to bend inwards according to the dotted line or to break under the process of shrinkage, leaving a space between the broken parts.

"The result was, however, very different; the thin parts were longer than the thick, and were bent by the process of shrinkage, the excess length being in proportion to the diminution in thickness, and the end-pieces C were broken in the mould as shown by the sketch, or according to D. In the case of castings in which the difference in the thicknesses was small, the fracture took place only when the gate was broken off with a blow of the hammer.

"In the thin internal parts the differences in shrinkage were less apparent."

Goujon ascribed these anomalies to the fact that the rate of cooling of the thin parts is in inverse ratio to the thickness; the whole or part of their shrinkage takes place while the larger thicknesses are still liquid and are capable of feeding those thin parts with sufficient metal to maintain equality in length throughout the system.

In the very important course of lectures conducted by M. Ronceray at the Ecole Supérieure de Fonderie in Paris, this question has been examined, and the distinguished Professor found himself in disagreement with Goujon as regards the mechanism of shrinkage in the experiment described above. He said:

"I do not think what Goujon says is correct; the shrinkage in length, in fact, does not begin to operate until after solidification, and it is therefore impossible to conceive of the thin parts being fed by the thick parts during shrinkage in the solid state. At the most, the liquid contraction might be compensated. We must therefore look elsewhere, and the most reasonable hypothesis appears to me to be the following:—

"The metal when heated must possess—contrary to what occurs when it is cold—a certain property of elongation or of contraction; the solidified thin parts are the first to exercise a tensile stress on the ends of the frames.

"As soon as they have become sufficiently solid and the ends are firm, they act through the frame on the thick parts, causing them to shrink; the latter, being still pasty, yield to this stress, while at the same time the thin parts cool and become firm. The shrinkage of the thick parts then takes place, but it is opposed by the thin parts already cooled. The shrinkage thus creates internal tensions and causes fractures."

It appeared to the author desirable to decide the difference between these two opinions and to determine whether cast iron is capable of elongation or contraction when hot. He therefore prepared a test bar 1 metre in length and having a thickness of 20 and 40 mm. (see Fig. 2).

After a preliminary test the author encountered the same anomalies as Goujon. He was unable, however, to discover what took place after the solidification of the first parts, and he then decided to construct the shrinkage recording apparatus as shown in the general view in Fig. 1, and illustrated in Fig. 7. Its construction consists of the three branches of the castings A_1, A_2, B (Fig. 1), which are fixed to the lower box by means of three iron fittings, q, r, s, bolted on to the bar. These branches are attached by irons n, o, p to the rods of the recorder, which form three amplifying sets, c, d, e (from 1 to 6), actuating three pencils, f, g, h, which record the movements of shrinkage on a common strip, i, propelled by clockwork, j, this band being tensioned by means of the weights l, m. Between the indexes n, o, p, and q, r, s there was a distance of 900 mm.

The experiment was conducted as follows:—The casting, which was green sand moulded under normal conditions, was placed perfectly level, and when the mould was closed the apparatus was placed in position and fixed to the three movable irons, n, o, p. At the moment of pouring the apparatus was started and kept in operation for at least two hours. The most noteworthy points of the experiment were carefully recorded.

At the outset the desirability of employing two methods of pouring was envisaged (Fig. 3). (1) Pouring by gate attached to the thin parts. The metal introduced under pressure traverses the thin parts before filling the thick bar, so that when the pouring is finished the thin bars are hotter than the thick bars, and (2) pouring by a gate attached to the thick bar B. The metal is also introduced under pressure and passes through the thick part before filling the thin bars, so that when the pouring is finished the thin bars, contrary to the preceding case, are coldest.

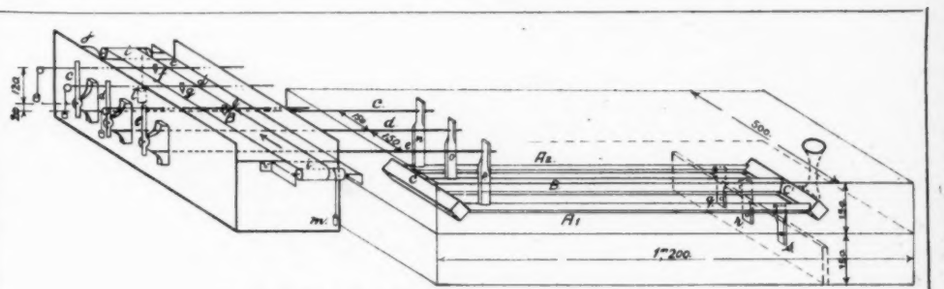

FIG. 1.—GENERAL LAYOUT OF THE APPARATUS USED.

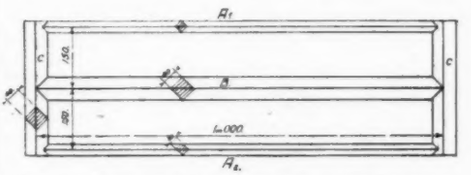

FIG. 2.—TYPE OF TEST PIECE USED. DIMENSIONS IN MM.

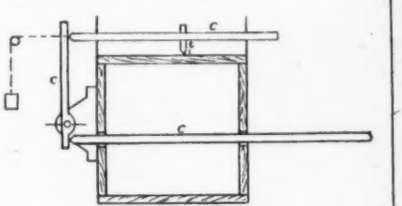

FIG. 6.

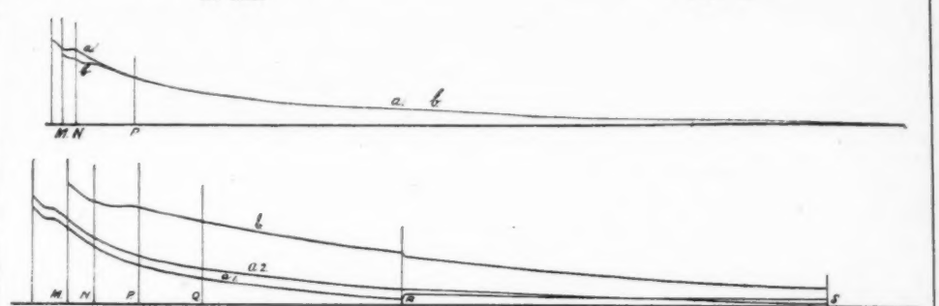

FIG. 4.—CONTRACTION CURVES REGISTERED BY THE APPARATUS SHOWN IN FIG. 7. UPPER CURVE, 1ST TEST; LOWER, 2ND TEST.

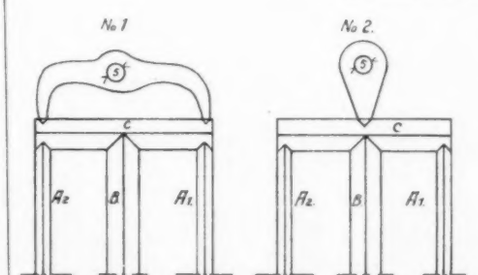

FIG. 3.—METHOD OF RUNNER, THE TEST FRAMES. THE ACTUAL RUNNER WAS 25 MM., AND NOT 5 AS SHOWN.

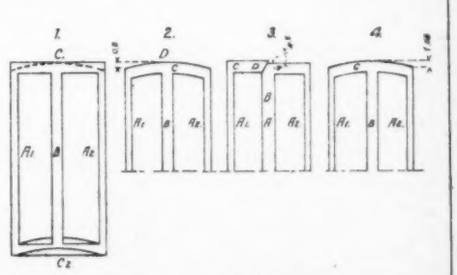

FIG. 5.—EFFECT OF CONTRACTION ON THE RESULTANT CASTING.

First Test.

The greatest care having been observed in preparing the mould, the following results were obtained:—(1) The curves (a) of Fig. 4 correspond to the bars A_1, A_2 and (b) to the bar B; (2) the appearance of the casting was as follows:—(a)

* A Paper read at the Leicester Convention of the Institute British Foundrymen.

There were no cracks; (b) the end-piece C was curved as shown in sketch 2 of Fig. 5, the inflection being 0.8 mm.; (c) the bars A_1, A_2 were curved, showing a deflection of 3 mm., and (d) the bar C, sawn along the line D, showed on cutting an apparent elongation of the bar A_1 of 1 mm.

An examination of the curves gave the following results:—(1) The total shrinkage of the bar B was 6.41 mm. or 7.12 per 1,000. The shrinkage of bars A_1 and A_2 was 7.66 mm. or 8.51 per 1,000. It can be stated straight away that the thin bars A_1 and A_2, even when the differences in length after sawing are taken into consideration, showed in fact a greater shrinkage than the thick bar B, or, to be precise:—

$$7.66 - 6.41 - 1 = 0.25 \text{ mm.}$$

(2) The shrinkage of bar B began 1 min. 50 sec. after that of bars A_1, A_2.

(3) During the interval M, N (Fig. 4), *i.e.*, 2 min. 40 sec., bars A_1, A_2 underwent no shrinkage, while bar B shrank 0.33 mm. in the same time. It may be said that the shrinkage of bar B is impeded by the bars A_1, A_2, for in this interval of time the fall of the curve b ought to have been more accentuated. It is therefore deduced from this that the thick bar has undergone a relative elongation.

(4) In the interval NP, *i.e.*, for 10 min. 55 sec. the bars A_1, A_2 resume their shrinkage, which amounts to 0.83 mm. more than

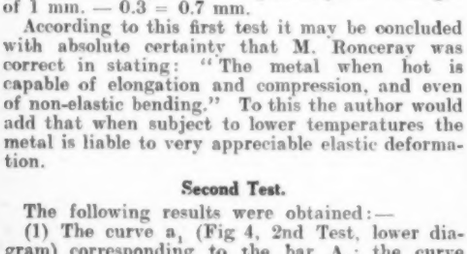

FIG. 7.—APPARATUS FOR THE DETERMINATION OF CONTRACTION.

bar B. It is found, moreover, that the curve b has a sense which is only slightly accentuated. It is now that the bars A_1, A_2 exercise a pull on the frame and cause the end-piece C to bend, making a deflection of 0.8 mm. There is, moreover, a slight but definite shrinkage of the thick bar, as the sense of the curve b is but slightly accentuated.

(5) From the moment P, or 15 min. after solidification has begun, until the completion of cooling the curves a and b coincide precisely. It is concluded from this that bar B exercises a pull on the frame and causes the bars A_1, A_2 to bend, making a deflection of 3 mm., which corresponds to a difference in length of 0.3 mm. As will be seen, this curvature of the thin bars is purely elastic.

(6) When the casting was sawn a difference of 1 mm. was shown, while the bars A_1, A_2 were straightened. The bars B and A_1, A_2 have therefore been subjected to elastic deformation, elongation and compression respectively for a length of 1 mm. — 0.3 = 0.7 mm.

According to this first test it may be concluded with absolute certainty that M. Ronceray was correct in stating: "The metal when hot is capable of elongation and compression, and even of non-elastic bending." To this the author would add that when subject to lower temperatures the metal is liable to very appreciable elastic deformation.

Second Test.

The following results were obtained:—

(1) The curve a_1 (Fig 4, 2nd Test, lower diagram) corresponding to the bar A_1; the curve a_2 to the bar A_2; the curve b to the bar B; (2) the casting showed the following characteristics:—(a) The end-piece C was broken along D and cracked along D' (Fig. 5, sketch 3); (b) the bar A_1 was straight and A_2 was curved; (c) the break D showed a difference of 4.5 mm.

An examination of the curves indicated the following results:—

(1) The shrinkage of bar B was 11 mm., or 12.22 per 1,000; that of bar A_1, 8.66 mm., or 9.62 per 1,000; that of bar A_2, 9.5 mm., or 10.55 per 1,000.

(2) The shrinkage of bar B began only 6 min. 20 sec. after that of bars A_1, A_2. Here the effect of the difference in pouring in the two tests was clearly apparent. At the moment M the bars A_1 and A_2 had already shrunk 2 mm.

(3) In the interval MN, *i.e.*, in 4 min. 50 sec., the curves a_1, a_2, b are identical; the three bars consequently show the same shrinkage, amounting to 1.66 mm.

From this it follows that the bars A_1, A_2, which are already very firm, exercise a pull on the end-piece C, and cause the movable index of the bar B, which is still partially liquid in the vicinity where the pouring was begun, to be actuated. In reality, therefore, there is a compression of the thick bar, which is a different thing from the feeding of the solidified parts with liquid metal mentioned by Goujon.

(4) In the neighbourhood of the moment N the bar B is completely solidified and tends to effect its shrinkage independently; this is seen in the interval NP where the thin bars shrink 1.08 more than the thick bar. This difference is clearly shown by a curvature of the end-piece C, as in the preceding test (No. 4, Fig. 5).

(5) In the interval PQ, *i.e.*, during 12 minutes, the curves then become identical again. This is because the bar C becomes more and more resistant and has to perform more shrinkage than the others, and consequently pulls on the frame and causes the bars A_1, A_2 to bend, the result being that the shrinkage of the thick part is retarded.

(6) In the interval QR the curves a_1, a_2 are identical, but the curve b is of a different character. The bar B shrinks more. From this it is deduced that the casting no longer forms a rigid whole, and consequently that the end-piece is cracked at D and D'.

(7) At R there is also a fracture after 1 hr. 3 min., this being shown by the discontinuity of the curves a_1 and b at that moment. It may therefore be stated that: The bar B was elongated elastically by 0.37 mm., as indicated by the fall of the curve; the bar A_1 was shrunk elastically by 0.5 mm; the curve a_2 did not exhibit any discontinuity, as the cross-piece only cracked so far as the bar A_2 is concerned, but it held.

(8) Between R and S there is no longer any cambering, and each bar effects its shrinkage freely. It will be observed, however, that the bar A_2 has shrunk more than the bar A_1, as it was still in part integral with the bar B. The difference of the shrinkages during this interval gives the value of the difference in the lengths on fracture.

From this test the author draws the same conclusions as previously, viz.: The metal is malleable when hot (temperature near melting point); it is increasingly elastic at lower temperatures and when cold; it is strikingly noticeable that the thin parts are more subject to shrinkage than the thick parts, both in the first and the second test.

Another observation is necessary: In the first test there were shrinkages of 7.12 and 8.51 per 1,000, and in the second 9.62, 10.55 and 12.22 per 1,000. It is therefore thought that in the first case the shrinkages are below the normal and in the second above the normal. One can therefore state that shrinkage may be promoted or retarded according to the method of pouring adopted.

In conclusion, it would appear from this study that a judicious selection of the method of pouring is necessary. It appears logical to begin the pouring of the castings at the thinnest parts, so that these may be fed with the hottest metal in order that the moment of solidification shall be as far as possible the same in the different parts of the casting. In the case of a less simple casting than that which has here been studied, it is well to determine the flow of the metal when the mould is filled.

It may happen—and this is generally the case—that this is not sufficient, and it will therefore be necessary to place heaters over the thin parts or chills over the thick parts. It frequently happens that, without observing it, the tensions are made too great; this occurs when risers or feeders are placed over very thick parts, *e.g.*, in the case of pulleys and flywheels.

In this paper many factors, such as temperatures and chemical composition, are lacking. The author would have liked to submit a more exhaustive study. He intended to make further tests by experimenting with two moulds at once constructed under the same conditions, one of which would preserve the casting intact, and the other would take the casting, which would be cut up to show the various parts immediately after casting. These two castings would be poured together with the same metal, gates of the same form and section being used.

It is hoped in this way to be able to obtain trustworthy comparative data at any moment during cooling.

I.B.F. Elects New Members.

At the Council meeting of the Institute of British Foundrymen, held prior to Leicester Conference, the following were elected to its various membership grades:—

As Subscribing Firm.

London, Midland and Scottish Railway Company; J. B. Corrie & Company, Limited, engineers, 15, Victoria Street, Westminster, S.W.1; and J. Jefferies & Sons, Limited, Hotwells Foundry, Hotwell Road, Bristol.

As Members.

J. Davies, Ironfounder, Cymric Foundry, Treforest, Glam.; P. Gundry, Works Manager, Wm. Brenton, Limited, Polbothie, Cornwall; J. J. Jones, General Manager, John Jones & Sons, Limited, Loughborough; G. T. Lunt, Director, Bradley & Foster, Limited, Darlaston; C. G. Smith, Chemist, A. Holt & Company, Water Street, Liverpool; G. Taite, Managing Director, Wycliffe Foundry Company, Limited, Lutterworth; James Bayne, Works Manager, Stoves Limited, Rainhill, Lancs; John A. Smeeton, M.I.Mech.E., Engineer and Managing Director, John A. Smeeton, Limited, 15, Victoria Street, S.W.1.; Percy H. Wilson, Foundry General Manager, Stanton Ironworks Company, Limited, near Nottingham.

As Associate Members.

David C. Bulloch, Pig-iron Salesman, Wm. Jacks & Company, Winchester House, Old Broad Street, E.C.2; A. E. Allen, Mechanical Engineer, 51, Norwich Union Chambers, Birmingham; W. Donnon, Foundry Superintendent, Lightalloys, Limited, Willesden Junction, N.W.10; A. J. Hancock, Foundry Engineer, Cylinder Castings, Limited, Mickleover, Derby; C. E. Jackson, Patternmaker, York Engineering and Foundry Company, Limited, York; S. Southcott, Foundry Foreman, Taylor & Sons, Limited, Engineers, Briton Ferry; and H. E. Warner, Foundry Engineer, J. W. Jackman & Company, Vulcan Works, Manchester.

As Associate.

H. C. Pillow, Toolmaker, Hodgson & Company, Henton Junction.

An Appreciation of the I.B.F. Work.

Mr. Harry Johnson, of the Sudan Government Foundry, Atbara, Sudan, in a letter to Mr. H. Stead, the honorary secretary of the Lancashire Section of the Institute of British Foundrymen, states that it is with very great pleasure that he has read the Papers presented to that Branch on foundry subjects, and regrets that he has been unable to participate in the discussions. He has followed this work through the medium of THE FOUNDRY TRADE JOURNAL, and wishes to thank the various authors who have provided him with matter which enabled him to keep up to date. Finally, he hopes to attend the meetings during the winter of 1928, when he expects to be in England.

THE NEXT annual meeting of the Association Technique de Fonderie will be held in Paris next October, the actual date of which is not yet fixed.

Iron Foundry Costing.*

By W. R. Wintle, F.C.W.A.

(*Continued from page* 477, *Vol.* 38.)

Pattern Shop.

Practically the whole of this shop's cost is chargeable against the foundry, and should be allocated as "direct." If any other contracts are being worked for other firms, then of course only that part which is applicable to the foundry should be charged. The pattern shop itself should be the subject of a separate trading account, and its charges to the foundry so made that every pattern can be traced and debited to the "castings order" it is made for. By charges it is understood wages, material, and shop overhead, with the usual management charges added.

Up to this point the wages and materials have been analysed and classified; stock books have been entered up and the total consumption for the month of the various materials is known. The repairs and maintenance account has also been posted, and it is known also what wages have been spent and also what materials on this account and on what part of the foundry equipment.

Establishment Charges.—The third element in costing is the establishment charges, which will be referred to in detail in the latter part of the Paper. The records gathered in the foregoing remarks are subsidiary to the final cost record, the completion of which can now be made with the wages and materials and establishment charges shown in their application. (See form No. 1 for proper set-out.)

DISTRIBUTION OF FOREMEN, Miscellaneous Yard Labour, Compensation, etc.

Month.	Foremen.	Miscellaneous Yard Labour, unallocated.	Workmen's Compensation.	Sundry Supplies, Medical, Ambulance, etc.	Total.	Departments of Foundry. Cupola.	Moulding Shop.	Core Shop.	Fettling Shop.	Smiths' Shop.	Machine Shop.	
Direct labour					£2,000	£100	£1,100	£200	£50	£50	£500	Figures to illustrate only.
Proportion of total						5 per cent.	55 per cent.	10 per cent.	2½ per cent.	2½ per cent	25 per cent.	
	£	£	£	£	£	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	
January ..	130	62	40	6	238	11 18 0	140 18 0	23 16 0	5 19 0	5 19 0	59 10 0	
February ..												
March ..												
April ..												
May ..												
June ..												
July ..												
August ..												
September												
October ..												
November ..												
December ..												

FORM NO 4.—DISTRIBUTION OF COSTS OF FOREMEN, ETC.

Melting Department of Cupola Cost.

Direct Wages: Cupola tenters; labourers handling iron and fuel; proportion of foremen's wages. *Materials*: Coke; ganister; limestone; bricks; fireclay; oxygen; feeding irons, etc.

Works Overhead Expense.—Repairs and Maintenance: Wages and materials on cupola and cupola equipment as shown by the repairs schedule. *Proportion of Charges for*: Power, lighting, insurance, rates, depreciation, laboratory, compensation, medical supplies, sundry stores.

Moulding Shop.

Direct Wages: All wages of moulders and helpers in dry sand, green sand, and loam moulding; all wages of moulders and helpers on machine moulding; all wages of moulders and helpers in bench or stump moulding. *Indirect Wages*: All labour in or about the shop, sand milling and mixing, breaking runners and risers, delivering castings to fettlers, lining ladles, cleaning up shop, etc.; proportion of foremen's wages and pattern carrying and yard labour. *Materials*: Sand, cowhair and manure, blacking, plumbago, chaplets, sprigs, coal dust, small tools, bellows, etc.

Works Overhead Expense.—Repairs and Maintenance: Wages and materials on boxes and flasks, iron patterns, moulding machines, benches, buildings, cranes, crane track, chains, and tools. *Proportion of Charges for*: Power, lighting, heating, insurances, rates, depreciation, compensation, medical and other supplies, sundry stores, water, etc. *Pattern Shop Charges*: All pattern-making cost.

Core Shop.

Direct Wages: All wages of coremakers and helpers, including core-turning machine workers. *Indirect Wages*: All wages of sand mixers, sand wheelers, oven men, sundry labour in and about the shop, delivery of cores to foundry, cleaning up, foreman, and yard labour. *Materials*: Sand, coke, coal, straw ropes, wood wool, core gum, rosin, core oil, wax wire, iron wire, small tools and core irons.

Works Overhead Expenses.—Repairs and Maintenance: Wages and materials on stoves, ovens, racks, core carriages, sand mixers, buildings, etc. *Proportion of Charges for*: Power, light, heat, insurance, rates, depreciation, compensation, medical and other supplies, sundry stores, water, etc.

Fettling and Cleaning Department.

Direct Wages: All wages of fettlers and blasters, chippers, tumbling, inspection, etc. *Indirect Wages*: All wages of labourers, cleaning up shop, proportion of foreman's wages, yard labour, weighman and castings, store clerk. *Materials*: All tools required for chipping, cleaning materials such as brushes, file card, sand-blast material, goggles, filling compounds, etc.

Works Overhead Expenses.—Repairs and Maintenance: All wages and materials on buildings, weighing machine, sand-blast apparatus, tumblers,

FOUNDRY TRADING COST ACCOUNT.

Month of 192

Dr.	Amount. £ s. d.	Total. £ s. d.	*Cr.*	Amount. £ s. d.	Total. £ s. d.
To Opening Stocks: Tons. Cwts.			By Sales of Castings Delivered to Customers		
Pig-iron (Foundry)			,, Sales to Stock not Delivered		
Scrap iron ..			,, Sales to Stock as Stock..		
Coke (Cupola) ..			,, Closing Stocks: Tons. Cwts.		
Limestone ..			Pig-iron—		
Sand			(Foundry)		
Coal			(Hematite)		
Hematite iron ..			Scrap iron		
Coke (Store) ..			Coke (Cupola)		
Other materials			,, (Store)		
To Wages:			Limestone ..		
Cupola			Sand		
Manufacture			Coal		
Labour			Other materials		
Repairs, etc.					
To Purchases:					
Pig-iron (Foundry)					
,, (Hematite)					
Scrap iron					
Coke (Cupola)					
,, (Store)					
Limestone					
Sand					
Coal					
Other manufacturing materials					
Materials for repairs					
To Stores Issues:					
Oils, grease, waste					
Materials for repairs					
Sundries supplies					
To Charges from Other Departments:					
Electricians					
Pattern Shop					
Carpenters					
Electric power					
Gas, etc.					
To Depreciation					
,, Suspense Account ..					
,, Rates, etc.					
,, General Expenses					
To Balance, being Profit for Month..					

FORM NO. 5.—FOUNDRY TRADING COST ACCOUNT.

* A Paper presented to the Leicester Convention of the Institute of British Foundrymen.

etc. *Proportion of Charges for*: Power, lighting, heating, insurances, rates, depreciation, medical supplies, sundry stores, water, etc.

Smiths' Shop in Foundry.

Direct Wages: Wages of smiths and strikers. *Material*: Coke for smiths' fires.

Works Overhead Expenses.—Repairs and Maintenance: All wages and materials on buildings, hearth, anvils, tools, etc. *Proportion of Charges for*: Power, light, heating, insurance, rates, depreciation, compensation, medical supplies, sundry stores, water, etc.

Machine Shop.

Where a fairly large machine shop is attached to the foundry it should be treated as a separate entity, with a separate profit-and-loss account of its own. In most cases repairs are carried out for the foundry, but also many of its machines are engaged in jobbing work for customers' orders.

The method of costing in a machine shop is entirely different from a foundry. The percentage method of pro-rating overhead expenses and establishment charges is no longer acceptable where the machines vary in type and capacity, as they generally do. Every machine centre is a productive unit of a different design and equipment, and represents a more or less constant earning power, in recovering by the machine rate method the total expenses of the shop. The machine shop should, therefore, like the pattern shop, be in a position to charge the foundry for all the work done on repairs and other contracts. It is important to know exactly what part the machine shop is playing in the final result of the foundry. The machine rate method is too involved to be attempted in this Paper, and is really a separate subject altogether, having no bearing on the foundry costing procedure. For the purpose of this Paper it will be sufficient to remark that all the wages, materials, and expenses of the machine shop must be gathered together and regarded as quite distinct from the profit-and-loss account of the foundry.

From the foregoing arrangement of collecting the foundry cost, it will be seen readiy that each department of the foundry becomes in itself a separate cost and capable of close analysis. In estimating, the method is invaluable, being both helpful and instructive in eliminating any charges connected with departments which are not concerned with the estimate. The last feature to be added to complete the cost is the general expense or establishment charges proper, which are not particular to any one department of a foundry, but common to all.

General Expense.

Under this heading will be gathered all those expenses which, strictly speaking, are outside the management control, but which are well known to be necessary in the administration of a company's affairs. Enumerating some of these items, of which the foundry has to bear its due proportion, are:—(*a*) Salaries of manager, secretary, accountant, clerks, time-keepers, etc.; (*b*) directors' fees and expenses; (*c*) salesmen and travelling expensses; and (*d*) telegrams, stationery, telephones, advertising, law costs, bank charges, office upkeep, auditors, and many other lesser charges.

As to how these expenses are presented in the "cost sheet" is a matter for each individual firm to decide.

Basis for Distributing Works Expenses.

More important than the collection of data is the method of its apportionment. A few leading thoughts on this will be instructive and valuable where a system of this kind is contemplated.

Power, Lighting and Heating.—Wherever possible, departments of the foundry should be metered and the actual consumption debited. If no meters are in, the horse-power-hours of the department motors can be used. Light and heat would have to be estimated and apportioned on the basis of the floor space involved.

MONTHLY REPAIRS SCHEDULE, showing a few Headings for Repairs to each Department.

Source of Expense.	Cupolas and Equipment.	Moulding Shop.								Fettling Shop.					
		Overhead and Jib Cranes.	Loco. Crane.	All Buildings and Crane Track.	Tools and Chains.	Loam Mills.	Electric Equipment.	Moulding Machines.		All Buildings	Cranes.	Sand Blast app.	Tumblers.	Tools, etc.	
FOUNDRY:															
Fitters															
Machine Shop															
Smiths' Shop															
Labourers															
Carpenter															
Purchased outside															
Pattern Shop															
Electricians, etc.															

	Core Shop.				Smiths' Shop.				Machine and Fitting Shop.							
	Stores and Ovens.	Other Drying apparatus.	Sand Mixers.	All Buildings.	All Buildings.	Hearths and Anvils.			All Buildings.	Lathe No. 2.	Drill No. 19.	Milling Machine No. 14.	Grinder No. 22.	Fitters' Benches.	etc.	etc.
As above, etc.																

FORM NO. 6.—MONTHLY REPAIRS SCHEDULE.

Date.....

DAILY CUPOLA RECORD.

Metal charged.	Tons.	Cwts.
Pig iron		
Bt. scrap		
Own scrap		
TOTAL		

Coke consumed
Limestone consumed
Castings produced
Loss in melting
Coke consumed per ton of metal melted =

FORM NO. 7.—CUPOLA RECORD.

Where no exact data at all is available, but the cost in money is known, then an estimate drawn up on a fair basis of what percentage is approximately consumed in each department of the foundry can be adopted, *e.g.*, over a period of twelve months' normal working. For instance, cupola or melting department may take 20 per cent., moulding shop 15 per cent., core room 5 per cent., fettling department 10 per cent., smiths' shop 3 per cent., and machine shop 47 per cent. (See form No. 2.)

Insurance and Rates.—Health and unemployment insurance can be charged direct to each department of the foundry because the figures are generally known. Fire insurance and local rates can be charged on the basis of the rateable value of each department. If not known an estimate can be drawn up which will meet the case. (See Form No. 3.)

Workmen's Compensation, Sundry Supplies, Foreman, Miscellaneous Yard Labour, etc.—These items should bear a very close relation to the number of employees, and should be distributed on that basis, the average number employed in each department each month being the divisor. Another method to distribute is by taking the total labour for each department of the foundry and finding its percentage to the total expense. (See Form No. 4.)

Sundry Stores.—Consisting generally of oils, grease, waste, emery cloth, and the many other numerous small items consumed, the basis is actual, by means of a stores issued tally against each department.

Depreciation, Renewals, Replacements.—There is a wide difference of opinion on this debatable subject. Nevertheless, every foundry has it to face, and every foundry will deal with the item in its own way, whatever suggestions are made. That it is real, and calling for attention in many foundries, no one will deny. The causes of depreciation may be briefly stated as follows:—(a) *Use*—that is ordinary wear and tear; (b) *Lapse of Time*—that is plant, machinery and buildings remaining idle for the considerable time, and (c) *Obsolescence*—that is the termination of the useful life of any equipment, owing to the necessary replacement through improvement in design or purpose, and which would make the equipment uneconomical to run on the old lines.

Market Demands.

The demand for a product or commodity naturally calls for a larger output, and this in turn often renders machinery obsolete. All buildings and machinery should be inventoried, and a plant register kept. Rates of depreciation for each department of the foundry should be applied to each part of the equipment, and a monthly charge made against current costs.

Replacements, through any of the causes already mentioned, should be borne by the depreciation account, and should not be chargeable to the current revenue account. Costs incurred in large overhauls, renewals, and heavy repairs should be met by a provision, based on previous experience to keep a fairly level cost per ton. That is to say, charge to cost an amount for each department of the foundry which will form the credit side of a suspense account, and as and when the overhauls, etc., of a heavy nature occur, debit them to this account.

Boxes and Flasks, etc.

Another costing item of expense is that for moulding equipment of a "loose" nature, such as flasks, boxes, iron patterns, etc. These are generally in constant use and just as generally getting broken and thrown into the cupola. Careful watch has therefore to be kept on this expenditure, otherwise the value, from a book point of view, may soon represent a sum of money which cannot be justified, and which becomes very mis-

Stock of materials at.....
Month of....., 19 .

	Foundry No. 3.	
	£ s. d.	£ s. d.
Stock		
Invoiced—		
Carriage and Wagon Hire ..		
Haulage		
Transferred		
Used		
Stock		

NOTE.—Other headings carried are Silky, Foundry 4, Low Silicon, Hematite Scrap, C.I. Scrap, Sand, Ganister, Coal, Coal Dust, Gas Tar, Prepared Oil and Napthalene, Core Oil, Core Gum, Newbold, Hematite, No. 2, Steel Scrap, Cupola Coke, Stove Coke, Limestone, Manure, Blacking, Sweepings, Straw Ropes, Plumbago, Wood Wool.

FORM NO. 8.—SECTION OF THE STOCK LEDGER.

leading. Repairs and renewals of this type of equipment are properly chargeable to current cost. New boxes, etc., which have to be made should be dealt with by a cost per ton of castings made, being fixed, and revised from time to time, capable of equalising the cost of making this new equipment, less the residual value or scrap value whichever may be the choice or policy of a particular foundry.

General Expense.—The expenditure under this heading is expressed in the "cost sheet" as an amount common to all the departments of a foundry, and as a percentage on the whole of the direct or productive labour of each department.

Job Costing.

The whole of the foregoing record, as seen by reference to the final cost sheet for the foundry's operations, is now the basis for any particular job cost, class cost or tonnage cost which may be wanted. The time recording will have already been done on each job number in compiling the departmental cost, and all that requires to be done now is to open a cost ledger account for jobs required, charging them with all actual expenditure in wages and material, and allocating to them the "works expense" and "general expense" as indicated by the various percentages and rates ascertained in the final "cost sheet."

In building up a jobbing cost system every care should be taken to balance both wages, material and establishment charges with the summary cost. The correct charge for iron used is often slipshod in its application, but with records kept by the foundry office the right proportions of mixtures can easily be worked out for special jobs, instead of taking some average cost per ton.

In dealing with the "on-cost," the following bases will be found equitable and practicable in distribution.

Cupola Cost.—The total cost of the melting department as per summary cost should be divided by the total weight of metal poured, and each job should bear its own proportion according to the weight it represents, both in saleable weight and wasters.

Moulding Department.—Each job will be debited with the actual cost of moulding. The "on-cost" will be distributed at the percentage it represents to direct labour in moulding as shown on the summary cost.

Pattern Shop Charge.—Distributed on an actual cost basis to every job where patternmaking is involved.

Fettling and Cleaning.—Generally it is not possible to book against every job, but where it is possible, this should be done, especially on intricate work. Distribution is otherwise on a tonnage basis.

Machining and Fettling and Smiths' Forgings.—The cost against each job should be on an actual basis. The "on-cost" in the case of the smiths' shop to be at the percentage it represents to the direct labour as per "summary cost." The "on-cost" in the machine shop is allocated by "machine rates," or if the shop is engaged on work of a similar nature, and machines of similar type and equipment, by the percentage method.

General Expense.—Distribution by the percentage rate as per "summary cost" on the *whole* of the direct labour of each job.

Conclusion.

In conclusion, one of the most difficult problems of the foundry is the half-filled shop, and the constant over-head and general expenses. By arranging the cost on the lines indicated one can see the total expense usually required to be borne by each department of the foundry under normal conditions of trade and manufacture. Therefore it will be much easier, when the output falls very much below normal, to know how much should be suspended through lack of orders, so that jobs made during a depressed period should not unduly suffer by comparison with those made during a period of trade activity.

Cost Accounts.—For the purpose of this Paper, the necessary forms of cost control accounts have been omitted, as being only of interest to the clerical side of the foundry.

Trading Cost Account.—As a comprehensive statement of the operations of the foundry, the "trading account" is, in conjunction with the "cost sheet," most valuable, in that it indicates not only the totals of the wages paid, materials purchased, but the stock in detail of all the principal items, both at the beginning and the end of the trading period. On the credit side of the account, the actual sale will be shown, the amount put to stock for orders, the amount put to stock as stock, and the profit or loss. (See Form No. 5.)

A New Pattern Shop Tool.

Having experienced a very great demand for a smaller machine than their Semi-Auto Pattern Miller Messrs. Wadkin & Company, of North Evington, Leicester, have designed the "Junior Pattern Miller." This latter, although of smaller capacity and somewhat cheaper in construction, is built on similar lines to the former.

Nothing has been spared to achieve the success of producing a combination of simple movements which lend themselves readily, conveniently and economically to the ever-varying details of engineers' pattern work as well as to all branches of intricate woodwork. The extensive range of adjustments in the machine save the operator from spending his time scheming out and preparing temporary rigs and fixtures such as is necessary when attempting to do such work on a machine which is unsuitable. He is, therefore, enabled to give his time, energy and attention to his work, resulting in the cost of production being reduced to a minimum, and the work turned out being of the highest grade, both in finish and accuracy.

Constructional Details.

The main frame is an exceptionally heavy casting, having accurately machined slideways to receive the overhanging arm, whilst the overhanging arm carrying the spindle head is mounted on the main frame and is raised and lowered by hand motion through a large hand-wheel placed in a convenient position on the arm. The spindle head is carried by the overhanging arm swivels between the vertical and horizontal. The principal angles are indexed and located by a spring plunger taper-pin engaging with suitable holes. Intermediate angles are readily registered by a degree scale and the head secured by a locking handle.

The cutter spindle is of special quality steel, the chuck being forged solid with the spindle. It is bored No. 5 morse taper. The back end is tapped out for a screw tang, and a securing screw engaging with a suitable flat on the taper tang, of the loose spindle when inserted in the chuck, ensures absolute safety to the operator. The spindle runs in heavy ball bearings and the thrust of the spindle is also taken by ball bearings arranged to take thrust load only.

The feed gear for cutter spindle is controlled by quick hand feed lever mounted in the centre of the capstan head. It is arranged with spring plunger to give definite depths of feed and is also provided with limit stops. The cutter spindle is driven by machine-cut spiral gears with ground teeth, running with the utmost smoothness, silence and absence of vibration. These gears are totally enclosed and arranged to run in grease. This method of driving enables the cutter spindle to drop below the level of the arm allowing the spindle to enter a corebox with its axis parallel to the surface of the work. This feature is a most desirable one, as it allows the cutters to be carried close to the bearings and dispenses with long boring bars. This drive also enables the spindle to be put in any angular position which often save resetting the work and increases the range of application of the cutters.

The driving gear spindle is mounted inside the arm, and revolves in heavy ball bearings. At the end of the arm nearest the main frame is mounted

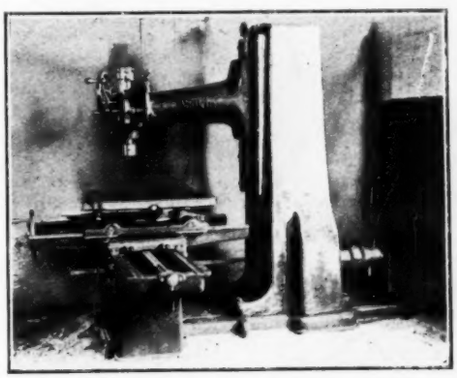

FIG. 1.—JUNIOR-PATTERN MILLER, BY WADKIN & COMPANY.

a pulley which is driven from a two-speed gear box in the base of the machine. The belt is arranged in such a manner that the raising and lowering of the arm does not affect the tension. Two speeds are provided suitable for both small and large diameters of cutters. The variation in speed is obtained from a gear box mounted on the machine base plate. The gearing is of steel and totally enclosed. The gear spindles are mounted on ball bearings and the variation in speed is made by lever handle. (This two-speed gear box is not needed when machine is motor driven.)

The work table has two motions at right angles, both of which are controlled by screw and hand-wheel. The table also has a rotary movement by hand lever and is arranged with a spring plunger taper-pin engaging in holes giving all the principal angles. This motion is extremely useful for dealing with all kinds of circular and radius work.

The table is graduated for convenience in setting the work. The centre of which is recessed so that cutters may be lowered below the surface. When not in use a cover plate is fitted to cover this recess. Suitable spring and dead stops are fitted to the various movements.

The machine is driven by two belts running continuously from the main line shaft, two loose and one fixed pulley being provided on the machine. One of these belts is crossed and the other open in order to give a reversing motion to the cutter spindle. The striking gear provided is operated from the front of the machine.

When the machine is to be driven by electric motor, the motor is mounted in the base of the main frame. It must be of variable speed and reversible.

The size of the work table is 28 in. × 28 in., whilst the net weight of the machine is 35 cwts. For operation 4-horse-power is required.

The Mechanical Properties of Iron Silicon Alloys.

The relationship between the silicon contents and the mechanical properties of iron-silicon alloys containing up to 20.00 per cent. of silicon has recently been studied by Th. Meierling and W. Denecke.* Melts of about 220 lbs. were prepared in a graphite crucible heated in an oil-fired furnace. There were used as raw materials a special soft iron containing 0.13 per cent. carbon, 0.00 per cent. silicon, 0.12 per cent. manganese, 0.02 per cent. phosphorus, 0.006 per cent. sulphur, and metallic silicon containing 97.63 per cent. silicon, 0.15 per cent. carbon, 0.40 per cent. manganese, 1.82 per cent. iron, and small amounts of aluminium, calcium, and phosphorus. The carbon content of the alloys was to be as low as possible, and did not exceed 0.40 per cent. There were prepared five series of test bars, according to Table I. The bars had a

Table I.

Series No.	Number of bars.	Kind of mould.	
I	4	Wet	Bottom cast; one gate. (See Fig. 1.)
II	4	Wet	
IIIa	2	Wet	Top cast; these bars were used to examine the shrinkage, the specific gravity, and the chemical composition.
b	2	Dry	
IV	4	Dry	Bottom cast; one gate. (See Fig. 1.)
V	4	Dry	

diameter of 0.787 in. and a length of 17.72 to 19.69 in. The transverse test bars were broken on 7.874 in. centres. The experimental results, together with notes concerning the structure of the bars, are given in Table II. In Fig. 2 the data obtained from the bars cast into green sand moulds are recorded by circles, that of the dry sand test bars by points. The transverse strength of some bars of series III are given in Table III and recorded in Fig. 2 by crosses.

Table III.

Sample No.	Si. Per cent.	C. Per cent.	Deflection. In.	Transverse strength. T/sq. in.
1	7.86	0.30	0.055	19.85
3	10.72	0.40	0.037	9.14
7	12.28	0.40	0.034	7.62
11	13.87	0.35	0.037	9.58
13	16.08	0.10	0.074	14.53
15	16.64	0.30	0.043	12.07
18	17.87	0.10	0.035	11.30
20	19.94	0.10	—	12.45

From Fig. 2 it is to be seen that the transverse strength and the deflection generally decrease with the increasing silicon content. A maximum of the transverse strength is obtained at about 16.0 per cent. of silicon; at the same time the chemical compound, Fe_3Si_2, and a eutectic graphite formation is to be seen in the structure. The dotted curve in Fig. 2 was drawn according to the frequency of the test values. The high test-values of sample No. 9 were caused by too low a casting temperature; the moulds were not filled, and the bars showed a lower shrinkage and a very dense texture. The low test-values of the samples No. 15 were caused by porosity. The green sand samples often showed a lower shrinkage than the dry sand bars. This is due to the fact that because of the rapid cooling-rate, together with the small solidification range, the green sand bars adhered to the mould. A marked difference of the transverse strength of the two kinds of bars, however, could not be detected; the open structure of the green sand bars is perhaps counterbalanced by the increased graphite content of the dry sand bars. The favourable influence of the graphite eutectic upon the mechanical properties was evidenced by the experiments of Schüz. In the present experiments the eutectic carbon content was obtained in the alloys containing about 16.0 to 17.0 per cent. of silicon. The formation of the compound Fe_3Si_2 takes place at about 1,045 deg. C. in the solidified alloy, and the separation of the graphite from the carbide occurs from 1,100 to 1,000 deg. C., according to the experiments of Honda and Endo. The coincidence of the two processes seems to cause an especially favourable distribution of the graphite and the formation of small particles of Fe_3Si_2. In all the cases where graphite flakes were formed segregations of Fe_3Si_2 occured, which because of their brittle nature lowered the transverse strength.

* Die Giesserei, 1928. No. 17; pp. 381 to 384.

Table II.

Sample No.	Si. Per cent.	C. Per cent.	Spec. gravity.	Shrinkage. Green mould. Per cent.	Shrinkage. Dry mould. Per cent.	Deflection. Green mould. Ins.	Deflection. Dry mould. Ins.	Transverse strength. Green mould. T/sq. in.	Transverse strength. Dry mould. T/sq. in.	Structure.
1.	7.86	0.30	7.15	—	2.05	—	0.054	—	18.85	Fine grained. Carbide along the grain boundaries; little decomposed. Some pearlite.
2.	9.52	0.30	7.15	1.85	2.20	0.044	0.0437	12.82	12.88	Fine grained. Inclination for forming shells. Carbide; little decomposed.
3.	10.72	0.40	7.36	—	1.80	—	0.038	—	10.03	Fine grained. Carbide being decomposed.
4.	11.75	0.30	—	1.80	2.05	0.0315	0.029	6.98	5.71	Fine grained, but radiated. Formation of shells. Carbide little decomposed.
5.	11.85	0.25	7.15	1.50	2.10	0.037	0.032	7.43	6.98	Fine grained. Inclination for forming shells. Carbide little decomposed.
6.	11.94	0.30	—	1.75	2.05	0.030	0.0319	6.73	6.47	Ditto ditto.
7.	12.28	0.40	7.22	—	1.90	—	0.031	—	7.30	Ditto. Carbide being decomposed.
8.	12.32	0.35	7.15	2.00	2.00	0.0315	0.034	7.68	8.00	Fine grained. Carbide very little decomposed.
9.	12.98	0.35	7.20	1.80	1.80	0.037	0.042	10.35	11.18	Fine grained. Carbide along the grain boundaries; little decomposed.
10.	13.26	0.12	6.93	1.85	2.00	0.026	0.0264	6.47	5.78	Coarse radiated. Carbide being decomposed. Green sand bars show no carbide along the grain boundaries.
11.	13.87	0.35	7.10	—	2.15	—	0.030	—	7.67	Coarse radiated. No separations along the grain boundaries.
12.	15.52	0.20	—	2.20	2.30	0.032	0.0319	8.25	6.60	Coarse radiated. Fe_3Si_2 finely divided in the interior of the crystals. No separations along the grain boundaries. Some graphite lamellæ.
13.	16.08	0.10	6.95	—	2.40	—	0.050	—	11.74	Medium grain size. Fe_3Si_2. Graphite eutectic.
14.	16.55	0.18	6.83	2.35	2.60	0.043	0.0433	12.57	11.74	Coarse grained, somewhat radiated. Fe_3Si_2. Graphite eutectic.
15.	16.64	0.30	6.78	2.30	2.65	0.025	0.029	(5.40)	(5.71)	Coarse radiated. Fe_3Si_2. Graphite eutectic and graphite lamellæ.
16.	16.69	0.20	6.74	2.40	2.80	0.039	0.0433	11.88	11.88	Coarse radiated. Fe_3Si_2. No separations along the grain boundaries. Some graphite.
17.	17.68	0.25	6.80	2.10	2.10	0.0315	0.032	7.48	7.93	Conchoidal fracture. Segregations of Fe_3Si_2. Graphite lamellæ.
18.	17.87	0.10	6.83	—	2.60	—	0.028	—	9.33	Fine grained. Fe_3Si_2. Graphite lamellæ.
19.	18.71	0.07	6.58	—	2.10	—	0.035	—	9.27	Conchoidal fracture. Segregations of Fe_3Si_2. Graphite lamellæ.
20.	19.94	0.10	6.55	—	2.10	—	0.035	—	8.45	Ditto ditto.
21.	20.78	0.20	6.55	2.15	2.30	0.0292	0.0308	6.63	7.29	Radiated. Fe_3Si_2 finely divided. Graphite lamellæ being formed.

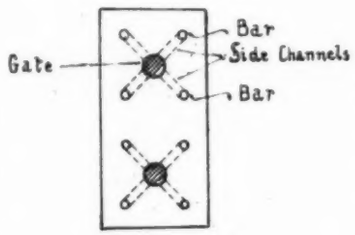

Fig. 1.

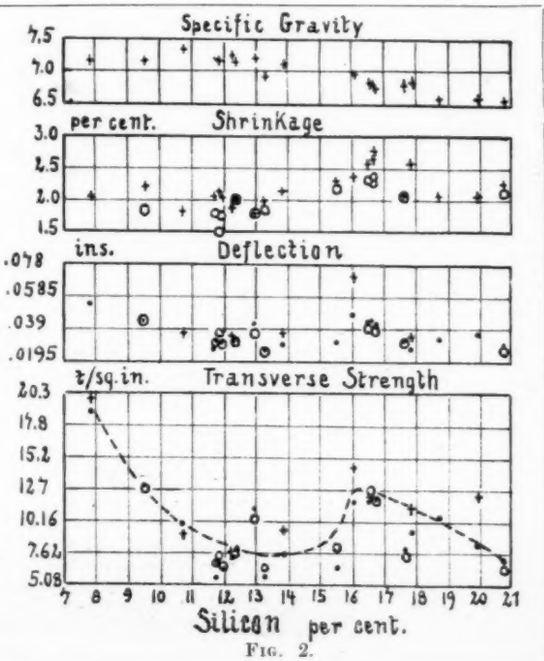

Fig. 2.

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CORE GUM,
WHITE DUST,
COAL DUST.

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Trade Talk.

THE STELEONITE METAL STAMPING COMPANY, LIMITED, are being wound up voluntarily. Mr. Claude Barker, 91, Moorgate, London, is the liquidator.

THE ADDRESS of the Harbour Improvement and Mechanical Engineering Company, Limited, is now Stone House, Bishopsgate, London, E.C.2.

THE IMPORTS OF FOREIGN IRON ORE at the Prince of Wales' dock at Workington for June amounted to 7,400 tons, against 8,200 tons for the previous month.

A SUPPLEMENTAL DIVIDEND of 8½d. in the £ is being paid by Mr. Joseph Oxley, iron, steel and machinery merchant, of Cadman Chambers, Norfolk Street, Sheffield.

MESSRS. OLDHAM & SON, LIMITED, electrical and mechanical engineers, of Manchester, have opened a new London depot at 40, Wicklow Street, Kings Cross, W.C.1.

MESSRS. F. C. HIBBERD & COMPANY, LIMITED, light-railway engineers, have removed their London offices from 98, Great Tower Street, E.C.3, to 16, Northumberland Avenue, W.C.2.

A FIRE AT the Woolston works of Messrs. John I. Thornycroft & Company, Limited, shipbuilders, last week, practically destroyed a building containing patterns and jute.

UNDER THE TITLE L'Hématite Belge Soc. Anon. a company has been formed with a share capital of 2,000,000 fcs. (to be increased later to 30,000,000 fcs.) for the purpose of exploiting iron-ore bodies and producing hematite by the Lambet-Auriol process.

MESSRS. WATSONS (METALLURGISTS), LIMITED, Lancaster Street, Neepsend, Sheffield, have just secured an order for a 30-ton electric furnace which is to go down in one of the Continental works. This furnace, when installed, will, it is believed, be the largest electric furnace in Europe.

THE MINISTER OF HEALTH has directed a public inquiry to be held at Bradford on July 24, concerning the controverey that has arisen in the West Riding over the question of smoke abatement. Several local authorities have adopted a by-law in uniform terms to which certain large industrial firms take exception.

AT A MEETING of the Council of the Sheffield Chamber of Commerce it was announced that a special meeting of the Tariffs Committee had been held to consider recent developments regarding the Spanish tariff. The Spanish Ambassador had indicated that there would be no increase in the duty on special steels, but this, it was asserted, was not sufficient, as it was necessary for changes in nomenclature to be introduced before the tariff could work smoothly and be satisfactory. It was in this latter connection that strong representations were being made to the Spanish authorities. The committee stated that there was strong reason to believe that no increase in the Belgian duty on steel bars would take place.

OWING TO THE expansion of business and the rapid strides made during the last few years, Messrs. Beecroft & Partners, Limited, St. Peter's Close, Sheffield, have found it necessary to acquire new offices and factory premises. In spite of the depression which has overhung the iron and steel industry, their business has gone ahead in the face of the keenest competition. This concern is now in possession of two works with head offices at Retort Works, Mappin Street, Sheffield, where all communications should be addressed. At St. Peter's Close Works, Sheffield, are the laboratories, testing, research and heat-treatment departments. The Scottish office is at 267, Central Chambers, 93, Hope Street, Glasgow.

THE ANNUAL REPORT of the Horseley Bridge and Engineering Company, Limited, states that negotiations which have been in progress for some time have resulted in the acquisition by the Company of practically the whole of the ordinary share capital of Messrs. Thomas Piggott & Company, Limited, of Birmingham, manufacturers of gasholders, filtration plants, steel pipes, tanks, etc. Under the terms of the purchase agreement the directors of Messrs. Piggott & Company have joined the board of the Company. Messrs. T. P. Barker and A. Dyson, managing directors of Messrs. T. Piggott & Company, Limited, have been appointed joint managing directors of the Company, and Mr. J. W. Baillie, assistant managing director and secretary.

SHIPMENTS OF MANGANIFEROUS IRON ORE are now being received steadily from Australia for consumption by Eastern blast-furnaces in the United States. This material averages around 50 per cent. iron and 15 per cent. manganese. It is being received in quantities governed by the amount of cargo space available. Foreign iron-ore offerings in America are scarce. Swedish ore, owing to the strike in Sweden, is not available, while the North African mines are supplying at a rate of about 8,000,000 tons of ore annually to European blast-furnaces in lieu of Swedish ore, as well as shipping the tonnage which they normally supply to Europe. A number of small mines which under normal conditions have been idle have been put in operation to make up the deficiency.

HOLDERS OF THE 5 PER CENT. (income-tax free) first debenture stock of the Barrow Hematite Steel Company, Limited, are being asked to give authority for the creation of £200,000 prior lien debentures and also to grant a moratorium in respect of interest on the debenture stock until December 31, 1930. All net profits earned by the company during the financial years 1928 to 1930 inclusive, however, are to be utilised for the payment of such interest so far as such profits will permit. In a circular calling a meeting of the shareholders, the directors state that these concessions, if granted, should enable the company to tide over the difficulties which all companies engaged in the iron, steel and coal industries are at present experiencing and to establish itself once more on a firm foundation. They point out that the holders of the second debentures have agreed to the proposals, and further indicate that if the scheme is not sanctioned there is no alternative but the appointment of a receiver.

A WRITER IN A RECENT ISSUE of the Supplement to the French "L'Usine" calls attention to alleged discrepancies in the returns of scrap exports. While the Italian official returns acknowledge the receipt of 385,000 tons of scrap from France during the period February 1, 1927, to January 31, 1928, the French Customs House authorities only return 215,000 tons of scrap exported from France to Italy during the same twelve months. The conclusion arrived at by the writer is that 170,000 tons were exported clandestinely or under different descriptions. The French iron and steel industry, we are told, is up in arms, the more so as it is further alleged that the material thus clandestinely exported is of much higher value (about three times the value) per ton than the kind of scrap agreed upon in the Commercial Treaty between Italy and France. The scrap taken out of France is, it is urged, badly wanted by the French industry, as the open-hearth process requires charges of at least 50 per cent. of scrap. The matter is to be the subject of inquiry.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Theory *v.* Practice.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—After reading Mr. Shaw's letter in your issue of June 28, 1928, methinks he had anticipated a letter from a certain quarter; but the question arises, why bother to discuss the obvious, particularly when one's time is fully occupied in other directions? It is but a statement of fact that our limitations are the extent of our experience, and my opinion is that it is utterly futile to attempt to convince a theorist he is wrong in his conclusions. The only way is to wait until he personally comes up against works problems and finds it is impossible to make theories fit practice. Having passed through all these stages myself I write with knowledge.

In your article in last week's issue, presumably having some reference to Mr. Shaw's attitude, you refer to equilibrium diagrams. In 1911 I attacked the reliability of the carbon equilibrium diagram, and Dr. Carpenter was the only one at the time to accept the position. Another equally eminent scientist who had begged me not to publish my results, because if proved they struck at the root of some theories upon which the metallurgical world was then working, very soon afterwards frankly admitted my accuracy. Others in their wisdom—recorded in the pages of your own Journal—ridiculed my conclusions, which, however, are now generally accepted.

In your article just referred to you say "the theoretical constitutes the only standard of reference," but in view of the previous paragraph of this letter it depends upon how far you wish to carry your statement as to whether it can go unchallenged. You are quite correct in your modification when you immediately follow this by saying, "Those people who clearly understand why and in what respect theory is inadequate in dealing with specific problems are more capable of satisfactorily dealing with the problem than others groping about in darkness." In other words those who know the weakness as well as the value of an equilibrium diagram are better able to deal with practical problems than one who has had only a theoretical training. Should this be your meaning we are in agreement.

In my opinion industrial research is of infinitely greater value than academic, which, in fact, is Mr. Shaw's point. In the metallurgical world, particularly with reference to cast iron, industrial research has a habit of disproving work done in the laboratory, and therefore what is the industrial value of extending the iron-carbon diagram, with its now known weakness, to include silicon variations, to be followed by variations of sulphur, phosphorus and manganese? Before attempting such a complex diagram it should be known whether silicon exists in one or more conditions, and if added as ferro, how much sulphur is fixed, and whether the manganese was originally present in the material used or added as ferro. These fine practical distinctions mean nothing to the chemist, but they mean everything to the man who understands even in part the application of physics to process. This "vision" is best realised by one whose practical follows a good all-round technical training, but such a man has little or no use for the five binary and eight ternary—thirteen diagrams named in your leading article of June 7.

Finally I quite agree with Mr. Shaw that the term "fundamental" is often used to cloak ignorance. It has always been a great pleasure to me to help those who are, to use your own term, "groping about in the darkness," but the purely theoretically trained is the hardest to help because of his difficulty in understanding the application of physics as well as chemistry to metallurgical problems, and particularly to process.—Yours, etc.,

E. ADAMSON.

18, York Street, Sheffield,
July 2, 1928.

Educational Value of the I.B.F.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The value of the work being done by the Wales and Monmouth Branch of the Institute of British Foundrymen as an educational factor may be judged from the fact that the Hon. Secretary of the Branch and some of its members—Mr. Galletly (Past President) for one—were invited to take part in the functions held at Cardiff last week in connection with the Institute of Technical Colleges. On Thursday last the Lord Mayor of Cardiff received delegates and friends at the City Hall, when it was expected Lord Melchett also would be present, but at the last moment he was prevented from coming.

I thought that your readers would like to know that the educational authorities value the work done by the Institute of British Foundrymen The Technical College is also at the disposal of the Branch for meetings throughout the winter months. It possesses a first-class mechanical department. Young men in and around Cardiff have a splendid opportunity of securing a good education at a very small cost to themselves.—Yours, etc.,

ETHEL RAWDEN.

13, St. Andrew's Crescent, Cardiff,
July 2, 1928.

Contracts Open.

Johannesburg, August 9.—Pig-iron, ferro-manganese and ferro-silicon, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 6,484.)

Reigate, July 14.—600 yards of wrought-iron fencing, 6 ft. in height, for the Town Council. Mr. F. T. Clayton, borough surveyor, Municipal Buildings, Reigate.

London, S.W., July 6.—Steel material (plates, angles, channels, etc.); crank and straight axles for locomotives; and laminated bearing springs, for the Bombay, Baroda and Central India Railway Company. The White Mansion, 91, Petty France, S.W.1.

Foundry Query.

Blow Lamps for Skin Drying.

Can any of your readers put us in touch with the makers of blow lamps for foundry use for drying moulds similar to the type made by the H.A.U.C. Manufacturing Company, of Brooklyn, New York.—Laurence Scott & Company, Limited, Gothic Works, Norwich.

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The long-continued depression in the staple industry of the North-Eastern area continues without visible signs of abatement, outputs having been again reduced by the blowing out of another furnace, while, for the present, supplies appear in excess of actual demands. The Cleveland ironmasters are thus faced with the alternative of either a further decrease in prices to meet the rapid expansion of home competition, or of again restricting production until conditions improve. In illustration of the existing position it may be noted that in May deliveries of Midland iron to Scotland totalled 13,000 tons, a figure substantially exceeding Cleveland deliveries, and the June figures are likely to reveal a similar state of affairs. Moreover, in the North of England the industrial situation becomes steadily worse, and the present disposition of consumers is to defer further purchases until after the holidays. Meanwhile the fixed minimum prices to home and foreign buyers remain unchanged as follows: No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

The slight improvement reported in last week's Tees-side hematite market has, unfortunately, already subsided and prices have again taken a weaker turn Although nominally 69s. is now recognised as the official minimum, specified mixed numbers are openly offered at 68s. per ton, with 6d. per ton extra for the No. 1 quality. On the North-West Coast no change is marked, Bessemer mixed numbers being still quoted at 70s. per ton at works.

LANCASHIRE.—The local markets for foundry pig are beginning to feel the effects of the holiday season and business is consequently on a further restricted scale. With regard to price movements, both Derbyshire and Staffordshire No. 3 foundry qualities are a shade easier at 69s. to 70s. per ton, delivered equal Manchester, with Scottish brands on offer at round about 87s. 6d. and Cleveland at 79s.

THE MIDLANDS.—Throughout South Staffordshire generally the demand for foundry iron continues in disappointing volume, consumers in the district having very poorly-filled order books, and consequently abstaining from purchasing, except for immediate needs. Quotations rule about as follows: Derbyshire No. 3, 60s. to 61s.; Northants, 55s. to 56s.; and North Staffordshire, 60s. to 61s. at furnaces. Lincolnshire and Cleveland irons are offered at 72s. 6d. and 81s. 9d. per ton respectively, delivered, and No. 3 Scotch iron about 89s. delivered.

SCOTLAND.—Business in Scotch pig-iron is, if anything, quieter, and the shrinkage is expected to continue until after the holidays. Three furnaces, one on foundry and two on hematite, have been put out of blast, leaving a total of 27 furnaces blowing in Scotland. Even with such a reduced make there is difficulty in disposing of it, as founders are very quiet and are only buying the smallest possible quantities for their immediate needs. Makers are unable to stimulate the demand by reducing prices, as their costs are such as to make the present price, 70s. per ton, quite unremunerative.

Finished Iron.

At Birmingham this week quotations for all grades of material have undergone no change, neither does the market present any new feature. There is much competition for orders for crown iron, and none of the now limited number of makers can secure sufficient tonnage to keep mills running with any degree of regularity. This iron is quoted delivered locally at prices varying between £9 and £9 15s., while nut and bolt iron is offered at £8 12s. 6d. to £8 15s. per ton. Very little support to the local mills is possible in connection with bolt iron, because of the Continental competition for this trade. The foreign product is quoted at £6 12s. 6d. delivered this area, and the bulk of what business is being placed (and that is not heavy) is still going abroad. The Staffordshire marked bar quotation is £12 at works.

Steel.

Reports from Sheffield indicate little change in conditions concerning the steel market, business generally being quiet, with an absence of any important changes in price movements. The production of open-hearth steel is on a fairly ample scale, and the output of special steels is even expanding. Steel hoops are £9 to £10 per ton. The basic wire-rod makers are experiencing sharp competition, but prices remain at £7 10s. for soft and £11 10s. to £11 15s. for hard. Acid qualities are £13 10s. In the tinplate market the home trade is not too brisk. Prices are quietly steady at 18s. 4½d. to 18s. 6d. basis for primes and 17s. to 17s. 3d. for wasters, in regular sizes, net cash, f.o.t. at works.

Scrap.

Corresponding with the depressed conditions in the iron trade generally, business in the markets for metal scrap continues quiet, although in the Midlands there is still a good demand for cast-iron material. Heavy machinery scrap, in cupola sizes, is firm at 67s. 6d. per ton delivered, and light cast-iron scrap at 55s. In Scotland supplies of all classes of scrap are moving away very freely, and consumers can readily obtain all they require at current prices, which about this time begin to ease a little owing to the holidays coming on and the suspension of traffic by the various works. Sellers are finding some difficulty in disposing of all classes of cast-iron scrap, particularly machinery, even at 66s. to 67s. 6d. per ton. Ordinary heavy cast-iron scrap to foundry specification is quoted at 62s. 6d., and steelworks cast iron in furnace sizes at 60s. Railway chairs are around 66s. 3d. to 67s. 6d. per ton. Light cast-iron scrap is 56s. 3d. to 57s. 6d. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—With only occasional fluctuations in values seldom exceeding the limits of a shilling or so each way, business in warrant copper offers little scope for comment on the week's market movements, but, on the whole, remains quite steady around £63 for both cash and forward positions. The future outlook is still somewhat obscure, although the general opinion is that, with stocks in producers' hands relatively small, it will be possible to stabilise the market shortly at a figure considerably above the present level.

Closing quotations are:—

Cash.—Thursday, £63 1s. 3d. to £63 2s. 6d.; Friday, £63 5s. to £63 6s. 3d.; Monday, £63 3s. 9d. to £63 5s.; Tuesday, £63 to £63 1s. 3d.; Wednesday, £63 2s. 6d. to £63 3s. 9d.

Three Months.—Thursday, £63 2s. 6d. to £63 5s.; Friday, £63 5s. to £63 6s. 3d.; Monday, £63 3s. 9d. to £63 5s.; Tuesday, £63 2s. 6d. to £63 3s. 9d.; Wednesday, £63 3s. 9d. to £63 5s.

Tin.—"Irregular" will best describe the current movements in standard tin, the market being still subject to extreme selling pressure, with values showing most erratic tendencies. On at least two recent occasions a sudden appreciation seemed to provide justification for the view that a previous decline was unnecessarily severe, but in each case the recovery was followed by an equally sudden set-back, and the general outlook is still very uncertain.

Official closing prices:—

Cash.—Thursday, £213 15s. to £214; Friday, £213 15s. to £214; Monday, £211 15s. to £212; Tuesday, £205 15s. to £206; Wednesday, £206 12s. 6d. to £206 15s.

Three Months.—Thursday, £210 10s. to £210 15s.; Friday, £210 10s. to £210 15s.; Monday, £208 7s. 6d. to £208 12s. 6d.; Tuesday, £203 10s. to £203 15s.; Wednesday, £204 12s. 6d. to £204 15s.

Spelter.—The market for ordinary spelter continues dull and uneventful, with quotations almost at stationary levels. Demand from the brass industry is, however, being well maintained, and, in spite of reports of light stocks, supplies are proving adequate. American advices indicate a steady demand on the New York market, where quotations are still above those current in London.

Daily quotations are:—

Ordinary.—Thursday, £25 13s. 9d.; Friday, £25 11s. 3d.; Monday, £25 7s. 6d.; Tuesday, £25 6s. 3d.; Wednesday, £25 8s. 9d.

Lead.—Lacking speculative interest and an active consumptive demand, the market for soft foreign pig is again without any outstanding feature of general interest. On the Continent and in America conditions are also less active, but the general opinion is that many important consumers will soon find it necessary to replenish their stocks, and that a revival of speculative interest will follow.

Closing prices:—

Soft Foreign Prompt.—Thursday, £20 17s. 6d.; Friday, £20 17s. 6d.; Monday, £20 11s. 3d.; Tuesday, £20 8s. 9d.; Wednesday, £20 11s. 3d.

Company Meetings.

Aluminium Corporation, Limited.—MR. KENNETH M. CLARK, the chairman, presided at the general meeting in London last week, and said the trading for the year had shown distinct improvement, due both to the welcome increase in the output of metal from their own furnaces and to the normal increase in the demand for electrical energy by the North Wales Power Company. Their sales to the North Wales Company, however, would decline as soon as that company's new power station came into operation within the next month or two, and owing to the recent somewhat serious fall in the selling price of aluminium the future profits would be affected; but, on the other hand, the company's agreement with their associated Norwegian company, under which they had the selling rights of the whole of their output of metal, provided them with all the requirements of aluminium for their rolling mill at a preferential price and brought the company an additional revenue by way of commission earned on the metal sold to other consumers.

William Cooke & Company, Limited.—MR. H. C. ELSE, the chairman, presiding at the annual meeting, in Sheffield, spoke of the difficulties with which the company had to contend owing to foreign competition and falling prices. He gave figures showing how the importation of wire rods and bar iron had grown, and how the company had had to accept reduced prices in order to obtain a share of the trade. The wire-rod mills had been most seriously affected—so much so that the company had closed their own mills for the time being, and had decided to take advantage of the Templeborough Rolling Mills, of which they were one-third owners. The wire ropery had worked very well, up to 93 per cent. of its capacity, but the fall in prices had been so enormous that it was impossible to make a commensurate profit. The fall in this case was not due to foreign competition, but simply to the competition of the makers in this country. Although there was a slight improvement in the iron and steel trades at present, he was afraid that the bad time was not ended yet. Their local taxation was three times more than it amounted to in 1914. It was true that they were likely to get some relief in that direction, but that was not to take place for a year and a quarter, and what would happen in the meantime it was almost impossible for anybody to say.

Personal Paragraphs.

MR. W. R. LYSAGHT has been elected chairman of Messrs. John Lysaght, Limited, in succession to the late Lord Buckland.

ENGINEER-CAPTAIN WILLIAM ONYON has joined the staff of Messrs. Vickers-Armstrongs, Limited, Barrow-in-Furness, in a consultative capacity and will represent the company in London.

AT THE RECENT graduation ceremony at the University of Edinburgh, the degree of Doctor of Science was conferred upon Mr. J. W. Donaldson, B.Sc., A.I.C., of Greenock. The thesis for which the degree was awarded was "The Heat Treatment, Volume Changes, and Thermal Conductivities of Grey Cast Iron between 15 deg. and 600 deg. C." Dr. Donaldson is a prominent member of the Institute of British Foundrymen, and his work on the subject of his thesis has been presented to the Institute from time to time in the form of a number of valuable Papers. At the recent Leicester Convention the Oliver Stubbs medal was awarded to him for his Papers, which embody the results of his work. Dr. Donaldson is also the author of the exchange Paper which has been presented to the Conference of the French Foundry Association next autumn on behalf of the Institute of British Foundrymen. Dr. Donaldson holds the position of chief metallurgist to Scott's Shipbuilding and Engineering Company, Limited, Greenock. This company has done much important work in the application of Diesel engines to ship propulsion, and it is due to the exacting conditions under which cast iron is used in this kind of work that has led Dr. Donaldson to carry out his now well-known series of researches.

MESSRS. B. WALKER and E. Normanton, carrying on business at Richmond Street, Bolton Road, Bradford, under the style of the West Riding Tin and Zinc Case Company, have dissolved partnership. Mr. E. Normanton will continue the business.

THE NEWCOMEN SOCIETY, for the study of the history of engineering and technology, paid a visit to Stourbridge recently and inspected several works in the district, among them being the chain works of Messrs. E. Baylie & Company, the ironworks of Messrs. John Bradley & Company, the brick and colliery works of G. K. Harrison, Ltd., and the nail works of Messrs. C. Home, Limited, Halesowen. Papers of technical interest were read.

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	63	0	0
Three months ..	63	3	9
Electrolytic	68	10	0
Tough	66	0	0
Best selected ..	66	0	0
Sheets	94	0	0
India	76	10	0
Wire bars	69	0	0
Do. July ..	69	0	0
Do. August ..	69	0	0
Ingot bars	69	0	0
H.C. Wire rods ..	73	5	0
Off. av. cash, June ..	63	13	11½
Do. 3 mths., June ..	63	14	0¼
Do., Sttlmnt., June	63	14	0¼
Do., Electro, June ..	68	19	0½
Do., B.S., June ..	67	5	10
Aver. spot price, copper, June	63	13	11½
Do., Wire bars, June	69	3	4
Solid drawn tubes			13½d.
Brazed tubes			13½d.
Wire			10d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13¾d.
Rods, drawn	10½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g. ..	10½d.
Wire	9½d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares ..	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

		£	s.	d.
Standard cash		202	12	6
Three months ..		204	12	6
English		205	0	0
Bars		206	0	0
Straits ..	(Nom).	209	12	6
Australian ..	(Nom.)	211	15	0
Eastern		208	15	0
Banca	(Nom.)	210	12	6
Off. av. cash, June ..		217	17	5½
Do., 3 mths., June		217	9	3½
Do., Sttlmt., June		217	7	0½
Aver. spot, June ..		217	7	5½

SPELTER.

	£	s.	d.
Ordinary	25	6	3
Remelted	24	10	0
Hard	20	0	0
Electro 99.9	29	12	6
English	25	15	0
India	21	0	0
Zinc dust	33	0	0
Zinc ashes	8	0	0
Off. aver., June ..	25	10	11½
Aver., spot, June ..	25	13	3½

LEAD.

	£	s.	d.
Soft foreign ppt. ..	20	11	3
English	22	0	0
Off. average, June ..	21	1	11½
Average spot, June ..	20	19	8½

ZINC SHEETS, &c.

Zinc sheets, English	33	15	0
Do. V.M. ex whf.	32	5	0
Rods	39	0	0
Boiler plates	29	10	0
Battery plates ..	31	5	0

ANTIMONY.

Special brands, Eng.	59	10	0
Chinese	40	0	0
Crude	33	10	0

QUICKSILVER.

Quicksilver	21	7	6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	8	0	0
45/50%	12	15	0
75%	20	0	0

Ferro-vanadium—	
35/40%	14/3 lb. Va.
Ferro-molybdenum—	
70/75% c. free ..	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbonless ..	1/2 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3½lb.
Tungsten metal powder—	
98/99%	1/7½ lb.
Ferro-chrome—	
2/4% car.	£32 0 0
4/6% car.	£22 0 0
6/8% car.	£21 12 6
8/10% car. ..	£21 0 0
Ferro-chrome—	
Max. 2% car. ..	£33 15 0
Max. 1% car. ..	£39 0 0
Max. 0.70% car. ..	£44 17 6
70% carbonless	1/2 lb.
Nickel—99% cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98/99% ..	£105 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose ..	£13 10 0
76/80% packed ..	£14 10 0
76/80% export ..	£13 5 0
Metallic manganese—	
94/96% carbonless ..	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over..	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/8 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¾ in.	3d. lb.
Do., under ½ in. × ¼ in. ..	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf ..	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—			
Hvy. steel	3	8	6
Bundled steel and shngs. ..	3 2 6 to	3	7 6
Mixed iron and steel	3	2	6
Heavy cast iron	3	0	0
Good machinery for foundries	3	2	6
Cleveland—			
Heavy steel	2	15	0
Steel turnings	2	8	6
Cast iron borings ..	2	3	0
Heavy forge	3	10	0
Bushelled scrap	3	2	6
Cast-iron scrap	3 2 0 to	3	6 0
Lancashire—			
Cast-iron scrap	3	0	0
Hvy. wrought	2	17	6
Steel turnings	2	2	6

London—Merchants' buying prices delivered yard.

Copper (clean)	52	0	0
Brass	38	0	0
Lead (less usual draft) ..	18	10	0
Tea lead	16	10	0
Zinc	16	10	0
New aluminium cuttings..	70	0	0
Brazierv copper	48	0	0
Gunmetal	49	0	0
Hollow pewter	160	0	0
Shaped black pewter ..	115	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	69/6
Hematite M/Nos.	69/-
N.W. Coast—	
Hem. M/Nos. d/d Glas. ..	79/-
,, d/d Birm.	86/-
Midlands—	
Staffs. common*	67/6
,, No. 4 forge ..	57/-
,, No. 3 fdry... ..	60/-
Shrops. basic	—
,, Cold blast, ord.* ..	—
,, ,, roll iron* ..	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3 ..	56/-
Derbyshire forge	59/-
,, fdry. No. 3 ..	62/6
,, basic	61/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	62/6
,, fdry. No. 3 ..	65/6
Lincs. forge	64/6
,, fdry. No. 3 ..	67/6
E.C. hematite	81/6
W.C. hematite	84/-
Lincs. (at furnaces)—	
Forge No. 4	60/-
Foundry No. 3	63/-
Basic	61/6
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3 ..	69/-
Northants foundry No. 3..	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3 ..	87/6
Glengarnock, No. 3 ..	87/6
Gartsherrie, No. 3 ..	87/6
Monkland, No. 3 ..	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom.	9	10	0 to	10	15	0
Nut and bolt iron	8	12	6 to	8	15	0
Hoops			..	11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip			..	11	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates.. ..			..	8	7	6
Boiler plts... ..			..	10	10	0
Chequer plts. ..			..	10	12	6
Angles			..	7	17	6
Tees			..	8	17	6
Joists			..	7	17	6
Rounds and squares, 3 in. to 5½ in.			..	8	17	6
Rounds under 3 in. to ¾ in. (Untested)			..	7	15	0
				and upwards		
Flats, over 5 in. wide and up				8	7	6
Flats, 5 in. to 1½ in.			..	7	17	6
Rails, heavy ..			..	8	10	0
Fishplates			..	12	10	0
Hoops (Staffs.) ..			..	10	0	0
Black sheets, 24g.			..	10	0	0
Galv. cor. shts., 24g.			..	13	7	6
Galv. fencing wire 8g. plain				12	10	0
Billets, soft	6	5	0 to	6	15	0
Billets, hard	7	2	6 to	7	12	6
Sheet bars ..	6	0	0 to	6	2	6
Tin bars ..	6	0	0 to	6	2	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 3
Wire	1 3½
Rods	1 3
Tubes	1 8½
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila. ..	20.76
No. 2 foundry, Valley	16.75
No. 2 foundry, Birm.	16.00
Basic	17.11
Bessemer	18.76
Malleable	18.76
Grey forge	18.01
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	32.00
O.-h. billets	32.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.85
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd., 9 and 10 ..	2.00
Wire nails	2.55
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	21/6
Durham and North.	
,, foundry	14/9 to 15/3
,, furnace	14/-
Other Districts, foundry ..	—
,, ,, furnace (basis) ..	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes ..	20×14	box ..	18/7½
,, ..	28×20	,, ..	37/3
,, ..	20×10	,, ..	27/3
,, ..	18¾×14	,, ..	19/-
C.W.	20×14	,, ..	17/-
,, ...	28×20	,, ..	34/-
,, ...	20×10	,, ..	22/-
,, ...	18¾×14	,, ..	15/9
Terneplates ..	28×20		34/- per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£17 10 0 to £18 10 0
Rolled Ord.	..£15 0 0 to £15 10 0
Nail rods	.. £15 7 6 to £15 15 0
Keg. steel nom.	..£33 to £35
Faggot steel nom.	.. £22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	.. £5 15 0 to £6 0 0

all f.o.b. Gothenburg.

PUBLIC LIBRARY DETROIT MICH.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½% ..	.. 50%
Water	63½% ..	.. 45%
Steam	60% ..	.. 40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
June 28 ..	63	1	3	dec.	1/3
,, 29 ..	63	5	0	inc.	3/9
July 2 ..	63	3	9	dec.	1/3
,, 3 ..	63	0	0	,,	3/9
,, 4 ..	63	2	6	inc.	2/6

Electrolytic Copper.

	£	s.	d.	
June 28 ..	68	10	0	No change
,, 29 ..	68	10	0	,, ,,
July 2 ..	68	10	0	,, ,,
,, 3 ..	68	10	0	,, ,,
,, 4 ..	68	10	0	,, ,,

Standard Tin (cash).

	£	s.	d.	
June 28 ..	213	15	0	inc. 65/-
,, 29 ..	213	15	0	No change
July 2 ..	211	15	0	dec. 40/-
,, 3 ..	205	15	0	,, 120/-
,, 4 ..	206	12	6	inc. 17/6

Tin (English ingots).

	£	s.	d.	
June 28 ..	212	0	0	inc. 65/-
,, 29 ..	211	10	0	dec. 10/-
July 2 ..	210	0	0	,, 30/-
,, 3 ..	204	0	0	,, 120/-
,, 4 ..	205	0	0	inc. 20/-

Zinc Sheets (English)

	£	s.	d.	
June 28 ..	33	15	0	No change
,, 29 ..	33	15	0	,, ,,
July 2 ..	33	15	0	,, ,,
,, 3 ..	33	15	0	,, ,,
,, 4 ..	33	15	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
June 28 ..	25	13	9	inc. 5/-
,, 29 ..	25	11	3	dec. 2/6
July 2 ..	25	7	6	,, 3/9
,, 3 ..	25	6	3	,, 1/3
,, 4 ..	25	8	9	inc. 2/6

Lead (English).

	£	s.	d.	
June 28 ..	22	5	0	inc. 5/-
,, 29 ..	22	5	0	No change
July 2 ..	22	0	0	dec. 5/-
,, 3 ..	22	0	0	No change
,, 4 ..	22	0	0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	4 15 0	4 17 6	5 0 0	5 0 0	5 0 0	4 17 6	4 17 6	4 17 6	4 17 6	5 0 0	5 7 6	5 7 6	4 19 9½
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 5 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	8 0 0	7 5 0	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	9 17 6	10 0 0	10 0 0	9 15 0	9 9 6	9 10 0	8 9 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	—	—	—	—	—	—	—

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IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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ZETLAND ROAD, MIDDLESBROUGH.

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PRACTICAL FOUNDRYMAN (leading hand with present employers) desires position as foreman, or assistant to manager, working not objected to; 20 years' experience of light and heavy, marine, including turbine, general engineering, and jobbing castings in loam, dry sand and green sand, weighing up to 25 tons; well trained in cupola practice.—Box 752, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRYMAN, having first-class experience in iron and brass founding, 15 years in business for self, desires position as Foreman; able to control men, and prepared to accept position in England or abroad; age 40.—Box 754, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN MOULDER for Iron Foundry making the largest type of Engine Castings in loam and sand.—Apply by letter, giving full particulars of experience, references, salary required, etc., to GALLOWAYS, LTD., Knott Mill Iron Works, Manchester. Envelopes should be marked "Foreman Moulder."

FOREMAN PATTERNMAKER required by Stove Grate and Gas Stove Manufacturers; must be able to control men; accuracy and sound experience essential.—Write fully in confidence, stating age, experience and salary required, in first instance, to Box 748, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

2-ft. 6-in. AMERICAN Radial Drilling and Tapping Machine, 1¾-in. dia. spindle.
2-ft. 6-in. ARCHDALE Radial Drilling and Tapping Machine, 2-in. dia. spindle.
Powerful 5-ft. centre Faceplate Lathe, by DEAN SMITH & GRACE.
New 18-in. swing APOLLO Combination Turret Lathe.
Powerful WORM GEARED STEAM WINCHES, cyls. 14 in. x 9 in., drum 19½ in. dia. x 3 ft. 8 in. wide.
Steam ASH HOISTS, direct acting and geared (by Alley & McLellan), extremely large selection.
SEVERAL HUNDREDS OF TANKS, rectangular and circular, 10 gallons capacity upwards.
100,000 ft. of 4-in. Wrought Iron Screwed and Socketed Pipes, about 18-ft. 6-in. lengths.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
ALBION WORKS, SHEFFIELD.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

PATENTS AND TRADE MARKS.

THE Proprietor of British Patents Nos. 208,572 and 208,573, both dated August 14, 1922, relating to "Process for the Production of Sponge Iron" and "Apparatus for the Production of Sponge Iron and other Metallic Products," respectively, is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patents and ensuring their practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois.

THE Proprietors of British Patent No. 224,941 are prepared to sell the patent or to license British Manufacturers to work thereunder. It relates to the manufacture of wrought iron.—Address: BOULT, WADE & TENNANT, 112, Hatton Garden, London, E.C.1.

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GANISTER, best quality, for Cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

PLUMBAGO.—To make room for large arrival middle of July, we offer 20 casks "Special" and 12 casks "Superfine" at 10 per cent. below price list (see our catalogue, page 8); unique opportunity.—WM. OLSEN, LIMITED, Hull.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

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11 ACRES WORKS SITE,
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145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.
SIDING CONNECTIONS
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WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.
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ERITH YELLOW LOAM and SAND
FINEST QUALITY.
Quoted F.O.R. or D/D. to Customer's Station. *Enquiries esteemed.*
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Foundry Supplies Dept.,
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Capable German Chemical Works
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Special firms for selling their moulding-powder in first-class :: quality. ::
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250 lb. MORGAN Cokefired "S" type ..	£48
600 lb. MORGAN Cokefired "S" type ..	£80
600 lb. MORGAN Cokefired "A" type ..	£85
800 lb. MORGAN Cokefired "A" type ..	£90

ALL RELINED READY FOR USE
EVERY SIZE LADLE (1 cwt. to 15 ton) in Stock
LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS
BUY FROM ME AND SAVE MONEY.
ALEX. HAMMOND, *Foundry Machinery Merchant,*
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